THURSDAY, AUGUST 17, 1882

THE LIFE OF IMMANUEL KANT

The Life of Immanuel Kant. By J. H. W. Stuckenberg, D.D., late Professor in Wittenberg College, Ohio. (London: Macmillan and Co., 1882.)

IN a former number occasion was taken—in connection with a review of Prof. Max Müller's translation of the "Kritik der reinen Vernunft"—to examine at some length the position of Kant's theory of experience in relation to scientific method.

Dr. Stuckenberg's book is of an order different from that of Prof. Max Müller's book. It has no pretensions to brilliance, nor does it attempt to reproduce the system of the thinker whose life forms its subject. It is a plain book, written for such plain people as are content to hear what sort of man Kant was without learning much of his teaching. But its plainness notwithstanding, it is a very useful work, abounding as it does in facts and common sense. No one can read it and continue to go about his business with the old impression that Kant was a metaphysical dreamer of that *a priori* school which found its apotheosis in Hegel as popularly conceived. We learn from Dr. Stuckenberg's pages, what ought to be much better understood than is currently the case, that Kant was an inquirer into the facts of nature, who was forced by the difficulties which presented themselves in his generalisations to investigate the constitution of experience itself. And we have material sufficient to enable us to gather that Kant's method in his criticism of knowledge was precisely the same as his method in his earlier criticism of nature. It is perhaps not to be wondered at that philosophy should since 1848 have fallen into bad repute. But it is to be wondered at, that with two or three exceptions, the English exponents of the sort of philosophy which is most in favour among educated men in this country, should know so little about the teaching of the great successor of Hume, a teacher whose criticisms have a greater and more important bearing upon the question of method than have those of Hume himself.

Apart from his work in philosophy and in mathematical physics and astronomy, the life of Kant is of peculiar interest in itself. He contributed largely to the bringing about of that revolution in literature which was carried to its consequences by Herder and Lessing, and which culminated in Goethe. He probably did more than any other man—even than Goethe—to give to Germany the intellectual position which she held in the early years of this century. But just because Kant's work was never of an order readily intelligible to ordinarily educated men, he remains to this day for the most part merely a great personality about whose thoughts little is known. What Kant was, as distinguished from what he did, will at least be collected from the pages of Dr. Stuckenberg.

It is open to doubt whether there is any idea about which educated people deceive themselves more than the supposed distinction between the "high *a priori*" method of philosophy and the experimental method of science. The methods of science and philosophy are really indistinguishable. They consist simply in the application of a previously conceived hypothesis to a given state of facts and the acceptation or rejection of the hypothesis according as it is or is not in harmony with these facts and adequate to their explanation. The exact sciences are distinguished from other sciences by the possibility of determining in their examples the question of harmony and adequacy in part at least by measurement. But there is much that comes properly within the description of science that is not exact science. Much of the body of doctrine which for example constitutes the science of biology cannot be tested by measurement, and hardly any of the conceptions of such branches of knowledge as philology or political economy can be so verified. If with Kant we look on philosophy as the science of knowledge itself as distinguished from its objects, and in this light examine the history of modern thought since his time, we find a conception of the nature of experience gradually evolved and developed by precisely the same process as in the case of the sciences—exact and otherwise. To understand how the idea of a difference in method sprang up it is necessary to go back to the pre-Kantian philosophers. Then there certainly did exist (just as there have existed in recent times) an almost universal belief (dissented from by Locke and his successors in England) that it was possible to deduce the nature of things by *a priori* reasoning from principles. And this belief was entertained by men of science almost as widely as by metaphysicians. Kant finally did for philosophy what Bacon did for science, and a careful consideration of the aberrations of some of his true successors show that however much they may have drifted into eccentricities they never lost sight of the new departure. No one for example who has given attention to the "Naturphilosophie" of Hegel supposes that Hegel meant to "deduce" Nature, or that he is dealing with anything else than the application of his fundamental conceptions to a certain phase of the problem of the constitution of knowledge. And yet not a few eminent critics have mistaken Hegelian irony for serious earnest. The time has come for recognising the fact that the rejection of the philosophical method, if it means anything at all, means the rejection of all that in science is not capable of reduction to space measurement, and men of science would do well to try to find out how much is implied in such a rejection. For such a purpose nothing is so well adapted as the study of Kant's works. Kant was a man of science who came ultimately to philosophy as a form of science. And for him the main feature of philosophy was that it purged the special sciences of a vast quantity of bad metaphysics, of unconscious assumptions which have been the real reason of those ultimate contradictions in their conceptions, which in modern times have proved so great a difficulty to the most acute investigators. It was not until middle age that he turned his attention to difficulties which had been forced upon his notice in the course of his researches in mathematical physics and biology.

One of the main lessons to be learned from Kant is the necessity of extreme caution in the formulation of the terms of all general problems. No one who has carefully studied Kant is likely to speak of the transition from the region of mechanism into that of organisation, or of the physical atom as conceivable objects of experience. Still less is he likely to reason about mind as though it were a form of energy, a substance or a thing. He will find himself

approaching the consideration of all such problems with a new light and an increasing disposition to limit the field of inquiry. He will also see that much that he took to relate to problems of the nature of objects within experience, really relates to the problem of experience itself. And he will probably agree with Kant in thinking that the difficulty of investigating this special problem is a difficulty not of kind but of degree, and this whether his conclusions are those of Kant or none at all. Just at present, when the tendencies of science are increasingly in the direction of general conceptions, it is difficult to avoid feeling that some knowledge of what Kant really taught ought to be far more widely diffused among scientific men than is actually the case.

R. B. HALDANE

RECENT ORNITHOLOGICAL LITERATURE

The Coues Check List of North American Birds. Second Edition, Revised to Date, and entirely Rewritten, under direction of the Author, with a Dictionary of the Etymology, Orthography, and Orthoepy of the Scientific Names, the Concordance of Previous Lists, and a Catalogue of his Ornithological Publications. 8vo, pp. 1-165. (Boston: Estes and Lauriat, 1882.)

Beiträge zur Ornithologie Südafrikas. Von Dr. Emil Holub and Aug. von Pelzeln. (Wien: Hölder, 1882.)

DR. ELLIOTT COUES is well known for the laborious works on ornithological literature which have flowed from his pen during the last ten years. No fact seems too trivial for record, no labour too great for this author when once he sets his mind to exhaust the literary history of any group of birds, or the ornithological fauna of a country. We have just received a copy of his second Check List of North American Birds, which appears to us to be much the most complete work of its kind which has yet appeared. An entire list of the Birds of North America, as politically defined, is here given, and we perceive that the number of recorded species has increased from 283 in 1814 (Wilson) to 888 in the present volume. Mr. Ridgway's estimate in 1880 was 924, but this total is reached by including in the North American List several species which are found in Mexico, as well as in the islands of Socorro and Guadeloupe. Dr. Coues considers that there are not more than thirty out of his 888 species "whose claims to be recognised by sub-specific names can be seriously questioned. Pp. 1-22 are occupied with the Introduction, a comparison of the present edition with the former Check List published in 1874, and a very interesting treatise on the "Use of Names." American ornithologists have so long ago adopted the trinomial system of nomenclature that it has become part and parcel of their writings, but so far it has not been adopted by Old World ornithologists, at least in the same sense as that in which the Americans employ the three names. To have to label a specimen *Icterus melanocephalus auduboni* (Gir.), Coues, is certainly more awkward than simply writing *Icterus auduboni*, and if the race is not worthy of a separate name it would seem better to suppress it altogether, and to quote the species as *Icterus melanocephalus*. The system too appears to us likely to bolster up sub-species and races which are not entitled to such recognition, as, for instance, in the case of the common Barn-Owl (*Aluco flammeus pratincola*), and the Magpie (*Pica rustica hudsonica*), which are not distinguishable even as sub-species from the European *Aluco* (*potius Strix*) *flammeus*, and *Pica rustica*, but seem to be retained by American authors under their system of trinomial nomenclature, chiefly because they have been once separated and have been called *Aluco pratincola* and *Pica hudsonica*. The Yellow-billed Magpie of California is placed upon the same footing as *Pica hudsonica*, and receives the trinomial epithet of *Pica rustica nuttalli*, whereas we have never yet seen proof of any gradation between it and *Pica rustica*, so that it would appear to be quite a good species, and entitled to full specific rank. These are small points on which European ornithologists are always likely to differ from their American brethren, but there can only be one opinion about the great value of the etymological portion of the present work, which has been most carefully written by Dr. Coues, the classical derivation of every generic and every specific name being most carefully given; and in this portion of his task the author acknowledges the obligations which he is under to Mrs. S. Olivia Weston-Aiken, "who cordially shared with him the labour of the philological investigation."

We are pleased to see that several etymological corrections recently set forward by Mr. Henry Wharton are adopted by Dr. Coues, who handsomely acknowledges the assistance given by Mr. Wharton. The latter gentleman is well-known in this country for his researches into the classical derivation of the names of birds, and he is now Secretary to a Committee of the British Ornithologists' Union, which is shortly about to issue a standard list of British Birds, in which special attention will be paid to the etymology of the names.

We have also on our table an account of the Ornithological Results of Dr. Holub's explorations in Southern Africa, written by the traveller himself, assisted by Herr von Pelzeln, of the Vienna Museum. This book contains a large number of illustrations, representative of bird-life in Southern Africa, the woodcuts being so well executed that we are able to gain a good idea of the nesting, habits, and economy of many South African species in their native haunts. Excellent accounts of the habits, especially of the breeding of a great number of species are given, and ostrich-farmers will find much that will interest them in the account of the South African ostrich. Several anatomical notes are dispersed throughout the volume, and many good figures of skeletons are given, including two plates devoted to the tongues of birds. Of the new species figured *Drymoica holubi* (Taf. I.) is scarcely likely to be really undescribed amongst the numerous *Cisticolæ* of Southern Africa, and *Lanius pyrrhostictus* (Taf. II.) is certainly only the female of *L. collaris*. All such works as Dr. Holub's add much to our knowledge of the geographical distribution of birds, especially when, as in the present instance, they are accompanied by a good map showing the country in which the collection was made.

Capt. Blakiston and Mr. H. Pryer have just issued a revised list of the "Birds of Japan," and it forms a most useful epitome of our present knowledge of the ornithology of this interesting country. Three hundred and twenty-six species are enumerated, notes being given on their geographical distribution in the different islands of Japan, and it would appear from the frequent mention of dif-

ferent museums that the Japanese have adopted this mode of education along with their other advances in civilisation. One of the most interesting features of the present list is the additional knowledge acquired by Mr. Snow's visit to the Kuril Islands, which locality, however, does not seem to be very rich in land-birds, though many wading-birds—gulls and petrels—appear to have been noticed. The authors have carefully identified all the species which have come under their notice, and in doubtful cases have forwarded specimens to England for comparison, so that little fault can be found with the present list, which seems to be the result of much good sound work, and we congratulate the authors on having placed the ornithology of Japan on such a satisfactory footing. A comparison of some of the smaller owls with the type specimens in the British Museum would appear desirable, and we have no doubt that Mr. Bowdler Sharpe would assist the authors, if specimens were forwarded to him for identification.

ICELAND

Summer Travelling in Iceland. By John Coles, F.R.A.S. (London: Murray, 1882.)

By Fell and Fjord. By E. G. Oswald. (London: Blackwood, 1882.)

THE most prominent—we ought perhaps to say, the one redeeming—feature of Mr. Coles's work is the fact that he occupied himself by taking observations of heights, temperatures, distances, and magnetic variations while travelling in Iceland. This is rarely done because of the difficulty of carrying instruments over a very rough, and in some places pathless, country. The result has been that the map appended to "Summer Travelling" is perhaps the most accurate which has yet appeared. Mount Paul, and a few more-familiar names, are strangely enough not inserted, but, on the other hand, the heights of the principal mountains and highlands are given in English feet; the crater of Askja is shown of its proper form; and the details of the Sprengisandr route are mapped. At the same time, the map is not so *clear* as that of Gunnlaugsson, who was careful to indicate the different surface soils—lava, sand, heath, &c.—by differences both of shading and of colour. If those who travel in a little-known country would provide themselves with a good aneroid, compass, and thermometer, and would learn before starting how to use them, and maintain a habit of using them constantly while on their travels, like Mr. Coles, it would be to the great advantage of science.

According to Mr. Coles, the magnetic variation in the extreme west of Iceland is 43° W., while on the east coast it is 34° W., and the compass error in different parts of the islands will thus vary by three-quarters of a point. Thus in the W. of the island the compass box must be turned until the N. end of the magnetic needle is over N.W., while in the E. of the island the N. end would require to be placed over N.W. by N., and then all the points marked on the card would indicate true bearings.

We may mention also a capital plan of the Haukadalr Geysirs, better, we believe, than any one which has appeared since that of Baring Gould.

Apart from the observations, the book contains nothing which is new to Icelandic travellers, or to those acquainted with the literature relating to travel in that country. The description of the Thingvellir-Geysir-Hekla-Krisuvik route, is as old as the hills, and becomes infinitely wearisome from much repetition. Four chapters out of eleven take us only as far as Hekla, and then the author did not ascend it. The journey across the Sprengisandr was quite uneventful, and the detour to Askja was without interest—that is, it did not bring to light any facts not previously observed by Prof. Johnstrup, Lieut. Maroc, or Mr. W. G. Lock. Also when we read that "Summer Travelling in Iceland" is a "narrative of two journeys across the island by unfrequented routes," we are disappointed to find the less frequented route without any interest, and the other by no means "unfrequented," but in fact the ordinary mail route between Akureyri and Reykjavik.

During the last twenty years books on Iceland have multiplied too rapidly, and there is no need for another work on the subject, unless it deals with some special features of the country scientifically, or unless it is a record of exploration, like plucky Mr. Watts's record of a journey "Across the Vatna Jökull." If somebody will further explore this tract of unknown country larger than Lincolnshire, or ascend and measure virgin peaks, or trace the lava streams of Koëtla to their source, or minutely survey the Krafla district, we shall welcome their records with open arms.

"By Fell and Fjord" is a bright, pleasantly written book, by a lady who has visited Iceland three times, has travelled over some of the less frequented paths, and has entered with wonderful spirit into the nature of the weird volcanic surroundings, and the tone and temper of the people, the language, and the literature. Miss Oswald is so fond of everything connected with the island, that she has braved discomforts which few ladies would willingly face. Her bravery impresses us immensely: she never feared to ford the most dangerous glacier river, never quaked while crossing the most treacherous bog, and was never discouraged by misfortunes caused by bad weather or a mistaken route. And then she is genuinely enthusiastic about the scenery, the wild gipsy life, and the cordial kindly people.

G. F. RODWELL

OUR BOOK SHELF

Madeira: its Scenery, and How to see it. (London: Stanford, 1882).

A USEFUL handbook to Madeira has just been published by Messrs. Stanford. It can hardly lay claim to be a scientific work, yet a fair knowledge of botany and kindred subjects is pre-supposed to exist by its author, Miss Ellen Taylor, and much of the interest in the excursions detailed is due to the introduction of this element. It presents, in fact, a very marked improvement over ordinary handbooks, and the treatment of the natural history section is excellent.

There is little of history to relate, and even the discovery of the island, which took place as recently as the early part of the fifteenth century, is involved in some obscurity. The race is mixed, and the aristocracy at least seems to have been recruited from Italy, France, and Flanders. The island is entirely volcanic, and no rocks earlier than Miocene exist in it. When volcanic action ceased is unknown, but even the most recent lavas seem to have suffered great denudation—no vapours are now exhaled—and the island is profoundly quiescent save from occasional earthquakes, as in 1748. The vast

majority of visitors gather their impressions of Madeira from a limited halt in the Bay of Funchal, or from a winter sojourn on its south side, yet fine as its coast line and peaks are seen to be, they are no more comparable to the grandeur of the northern side than the cultivated banks of the Rhine are to the gorges of the Yosemite. The south side is almost destitute of forest growth, except the introduced sweet chestnut, oak, and maritime pine, for the native juniper and dragon trees are almost extinct, but in crossing the dividing ridge another world is entered. Here all but the highest peaks are clothed with densest virgin forest. The naturalist may penetrate at will the wildest gorges, for the only paths into their recesses are the beds of half dried torrents.

The common distinctive feature of all these gorges is the precipitous nature of their sides, which time seems not yet to have weathered into angles of repose. The verticality is everywhere appalling, yet giant evergreens cling to every nook and crowd on every terrace. Some of the laurel tribe reach immense girth, and are quite inaccessible to the woodman's axe, rotting as they stand, and forming soil for carpets of Killarney, filmy, and hares-foot ferns. The warm, moist, and shady valleys form a paradise for ferns, the Dicksonia, Woodwardia, and Asplenium rivalling each other in size. The botany of the island is of great interest, especially in its relations to that of Europe and Africa; but the visible fauna, except Mollusca, is meagre, and the comparative absence of birds and butterflies is felt. Beyond the foreground of vast walls of red and brown rock, often 3000 to 4000 feet high, clothed and softened by dark green foliage, are peaks weathered into most fantastic forms, and rising to 6000 feet. But if this grand scenery could become monotonous, there are English moorlands on the Paül da Serra, barren tracts of rock at the extremities of the island, cultivated country with lanes hedged by fuchsias and hydrangeas at Camacha. The coast-line is magnificent in the extreme, one headland on the south presenting a vertical cliff to the sea of 2000 feet, and another, a mountain clothed with myrtle on the north, being scarcely inferior to it. The ascent of some of the peaks might tax even an experienced Alpine climber's nerves; but the effect of ocean rising to the skies like a blue wall all round is very striking when seen for the first time from a lofty island peak. In summer the heat is not oppressive among the mountains, and now that the fares are no longer unreasonable, one with an overtaxed brain seeking rest might make a worse choice than Madeira for a ramble. To him Miss Taylor's exhaustive book is inexhaustible, and the itineraries in it, sketched by Mr. Charles Cossart, invaluable.

No mention of Madeira is complete without allusion to its staple produce—wine. The export seems never to have exceeded 20,000 pipes annually, and though this was reached as early as 1750, yet this is far below the producing power of the island. The vines, destroyed by Oideum, have again severely suffered from Phylloxera, but the shipments, owing chiefly to the persistent efforts of Messrs. Cossart Gordon, are steadily recovering. It cannot be too widely known that Madeira is a pure wine, for at the price of grapes there, there is no incentive to use anything but grape juice in its production, though Madeira is exported to other wine countries, presumably for manufacture into sherry. The retail price is only artificially maintained by a pretended scarcity.

J. STARKIE GARDNER

Tschermak's Lehrbuch der Mineralogie. Part II. (Vienna: Alfred Hölder.)

IN this part of Prof. Tschermak's text-book the discussion of the optical and physical characters of minerals is continued and concluded in a manner more scanty than was perhaps to be anticipated from the first part. The results of many of the most recent additions to our knowledge of the structure of mimetic and twin-crystals, such as milarite, microcline, &c., as shown by their optical properties, are, however, included. In the chemical introduction which follows, too much space is devoted to the exposition of the fundamental principles of chemistry, such as those of equivalents, atoms, and the theory of types; as also to the principal simple tests for the various elements. A fair knowledge of chemistry is absolutely necessary to the mineralogist, and Prof. Tschermak might well have expected his students to bring such a knowledge with them. In this case his exposition is unnecessary, while if the student is ignorant of chemistry, it is hardly likely to be adequate, and it undoubtedly diminishes the space available for the principles of isomorphism and polymorphism.

Considerable space is given to the description of the situations in which minerals are found, and of their associations in beds and veins. Another chapter is devoted to mineral genesis and to the decompositions and transformations which minerals are liable to under the action of natural agencies. These subjects, common to the mineralogist and geologist, are apt to suffer through being relegated by each to the other, and we are glad to see the importance attached to them by Prof. Tschermak.

The systematic description of the principal minerals is to occupy the whole of the third part. This volume extends as far as the elements and sulphides, and gives us a foretaste of what is to come. The descriptions are well done, and give much more information than the ordinary text-books do. This information is, moreover, given in general language, and the different forms are better and more fully illustrated than is usually the case. The minerals discussed are those of importance either from their utility, the frequency of their occurrence, or their scientific value; and the selection, from this point of view, is well made.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.]

Scientific Exploration in Egypt

NOW that we have embarked in a war in Egypt, it is to be hoped that steps will be taken to have a proper staff of scientific explorers attached to the army with facilities for conducting their investigations. There are periods of rest in a campaign during which soldiers and others may be usefully employed in conducting excavations at comparatively slight cost; and difficulties in the way of investigation, arising from the requirements of trade and industry, disappear in time of war. The deposits of the Delta require to be examined. The gravels of the Nile Valley have to be connected with their animal remains. Much has to be done for the earliest and best period of Egyptian art, and the Stone Age of Egypt has to be fixed with certainty, the importance of which cannot be over estimated in connection with the earliest civilisation of the world.

I trust also that we shall not rob Egypt of her antiquities to any great extent. It may be useful to complete our typical series to a limited extent, but if Boulak should be happily preserved, I hope it will be preserved for Egypt, and not brought home. Nothing would serve more to prove that we go there to civilise and not to rob. The means of communication are now so easy that all who are interested in Egyptology can see it there. Steam and railways have materially altered the requirements of education in this respect. Humanity, and British humanity in particular, now pours through all the great arteries of the world,

and people observe and study more abroad than at home. The time has passed when antiquities should be regarded as trophies of war. It is no longer necessary for instruction to hoard up valuable specimens of foreign antiquities in European museums. So long as science has access to the materials of knowledge, that is all that it is necessary to bring away; and national museums, with the limited space at their disposal, should more and more become devoted to local collections. Besides which, it should be remembered that the atmosphere of Egypt preserves antiquities in a way that no other climate can do; and when this fact hereafter becomes fully impressed upon the public mind, the time may come when subscriptions will be raised to take back obelisks and put them up again in their proper places; at any rate we have enough of them weathering and withering in smoke and damp. They are quite out of place in European towns, and seem to hold up a finger of caution to us to proceed no further in that direction. But the opportunity for exploration should not be lost. The French savants did their work thoroughly during their military operations in that country, and it would be shameful if, with the knowledge now at our disposal, the British expedition did not achieve more for the promotion of science than was effected by Napoleon half a century ago.

Carlsbad, August 3 — A. PITT-RIVERS

Francis Maitland Balfour

THE memoir of Prof. Francis M. Balfour, published in NATURE, vol. xxvi. p. 313, appears to have been founded, as far as his life at Harrow is concerned, on incomplete information; and I therefore ask your permission to supplement it with my own reminiscences.

He entered Harrow School in January, 1865, and when he had reached the upper part of the fifth form in 1867, I was appointed to give instruction in natural science. Although this subject was not taught in any of the forms which Balfour passed through, he soon afterwards eagerly availed himself of the opportunity offered of taking lessons in practical work in biology. This continued without intermission until he left the school for Cambridge more than three years afterwards. He was always ready to spend as many hours as I could give him for work with the microscope and in making dissections. With Dr. Rolleston's "Forms of Animal Life" as guide, he dissected nearly all the typical examples described in that book. In the same way he gained a knowledge of osteology, using a small collection of skeletons which received, for his special benefit, the important additions of a complete crocodile, and an armadillo, several incomplete skeletons of ornithorhynchus, and echidna. No part of comparative anatomy was neglected, but of such an extensive subject, much of his knowledge was necessarily derived from books only, but it was sound, being based on Huxley, Müller, Kölliker, and the like. He had the opportunity also of learning elementary botany.

All this work was carried on under conditions with which only a boy of his energy and indomitable perseverance could have coped. At first he had some difficulty in acquiring skill in the purely mechanical details of dissection, but he determined to overcome this difficulty, and he succeeded. The time at his disposal for biology was chiefly the half-holidays, and for such work no marks could be given by his form masters, but on the contrary, it is only too certain that his position in other subjects was affected by his devotion to natural science.

Those who managed the affairs of the School Scientific Society in 1868 (two years before Balfour left Harrow), showed their appreciation of his remarkable powers by asking Prof. Huxley to award the prize, which had been offered, through the liberality of Mr. C. J. Leaf, for the best essay written during the previous holidays, being a description of some district known to the author. This unusual step was taken when it was found that the essay sent in by Balfour and another by his friend A. J. Evans, were of such rare merit, that it was felt that they were worthy of being brought under the notice of such a distinguished man as Prof. Huxley. His opinion of the value of these essays fully justified this view.

Balfour's knowledge of geology was chiefly gained at home, and no doubt it was of considerable service to him in the competition for the Natural Science Scholarships, which he gained soon after he went into residence at Cambridge.

Whether the teaching referred to in the previous lines was of advantage to him or not, could be best determined by himself, and it is interesting to have his judgment on this point when the recollection of it was fresh in his mind. In a letter dated "Cambridge, April 28, 1871," he says: "Many thanks for your congratulations on my success, which is certainly chiefly due to you." This opinion he again very warmly expressed to me when I had the pleasure of spending a few days with him in the same year after the meeting of the British Association at Edinburgh.

He left Harrow in August, 1870, having spent nearly six years in the school. — G. GRIFFITH

Harrow, August 7

I AM sorry that I omitted in my brief sketch to point out the benefits which Balfour undoubtedly derived from the science teaching at Harrow, and I am sure my friend Mr. Griffith will understand that it is as far as possible from my wishes to fail in acknowledging the fruit of the labours which he has been carrying on there these several years with such zeal and energy. There can be no doubt, I think, that the training which Balfour had under Mr. Griffith not only helped towards his gaining the scholarship, but materially contributed to making him the man he was. What I wrote concerning his reputation at Harrow, referred rather to what I understood was the general opinion of the school, than to Mr. Griffith's own forecast of what Balfour might become; the latter I have known for a long time to be so sanguine as to come near the truth. — M. FOSTER

On "getting" Coal by Means of Caustic Lime

IN an article on this subject (NATURE, vol. xxvi. p. 299) Mr. William Galloway states that this system "has been found by experiment to be incapable of breaking down a hard rock or shale roof," and is, therefore, not likely to have anything but a limited application.

Will you allow me, as one who has had a good deal to do with the new process, to assure Mr. Galloway that so far as it has yet been applied, it has answered every purpose in respect of which gunpowder or wedging have been hitherto used.

We have not yet had time to make a series of experiments with the lime-process on hard rock, &c., as our attention has been until now turned exclusively to the getting of coal, especially in those mines in which, from their fiery nature, the use of powder has been prohibited. In the Shipley Collieries, where the lime-process has been in constant operation for many months, it is regularly applied to one of the hardest seams in the Midland coal-field, the toughest part of which is that next the roof, and this portion could never be got by wedging in the ordinary way, but had subsequently to be hacked down into slack—by the lime process, however, the coal is parted clean from the roof, along the entire face operated on.

In other districts where it has been proved to be a complete success, the places selected for experiment were invariably the hardest in the mine. The cases where the tamping has been blown out are extremely rare, and have been due to causes immediately and easily rectified.

We have no reason to believe that the process would fail in its application to the mining of shales, iron ores, &c., and this point will be settled by experiment before long, pending which Mr. Galloway's conclusion on the subject is at least premature.

PAGET MOSLEY

81, Warwick Road, Earl's Court, August 10

IN stating that the caustic lime process was likely to have only a limited application in coal-mining operations, it was not my intention to convey the impression, as Mr. Mosley appears to think it was, that the area of its usefulness would necessarily be a small one. On the contrary, I believe it could be successfully employed in getting coal under a large variety of circumstances.

Mr. Mosley's connection with the subject could not well be more intimate than that of the gentlemen who supplied me with the information brought forward in the article referred to, and I understood them to say that experiments had been made with the roof of Shipley Collieries, giving results which amply justified the conclusions I stated.

The tamping was blown out of three or four of the holes which I saw operated upon, and this is certainly not what would be called an "extremely rare" occurrence. At the same time it did not appear to affect the final result in any way.

I said nothing about the probability of the process failing or succeeding in its application to the mining of shales, iron ores, &c., and stated no conclusion in this connection which could in any way be affected by the results of the experiments which Mr. Mosley says are pending. WILLIAM GALLOWAY

Cardiff, August 14

Science at the Victoria Hall

THE immediate object of the Victoria Hall Committee is to provide healthy amusement in place of the unhealthy sort too often found in places of cheap recreation, and does not appeal specially to scientific men as such. But they have a scheme on hand for next autumn to which I venture to call your attention. They would like to devote one evening in the week for popular lectures, and as a previous experiment they propose to have during October and November a series of very elementary popular addresses on scientific subjects of about half an hour in length, to be introduced in the beginning, or middle, or end of the temperance demonstrations which take place on Friday evenings. It is hoped that an interest in such matters may be awakened in the audience (usually numbering ten or twelve hundred, or during the winter more than this), which assembles at these demonstrations. It is an audience less of artisans than of labourers and costermongers, among whom the demand for scientific teaching must be created as well as supplied. If once it can be shown that such addresses are appreciated, we have good hope of efficient help in carrying them on, but we should be grateful for offers of help in the pioneer course. Dr. W. B. Carpenter, Dr. Richardson, and one or two others have given conditional promises, but we have not yet sufficient names for a long enough series to try the experiment fairly.

To simplify and popularise science to the utmost, without lowering it, is not a task which can be performed by those who have no qualification except goodwill, and as, unfortunately, the Victoria Hall is not yet self-supporting, the committee cannot offer anything like adequate remuneration for the services of competent and therefore busy men. They would gladly be responsible for the expense of providing lime-light, or hiring apparatus for experiments, but beyond this they must appeal to the public spirit and generosity of scientific men.

Communications may be addressed to the Honorary Secretary, Royal Victoria Coffee Hall, Waterloo Road, S.E., or to Miss C. A. Martineau, Walsham le Willows, Bury St. Edmunds.

ONE OF THE COMMITTEE

Spelling Reform

IN your note last week on the United States Spelling Reform Report, there is a slight misapprehension. It is said that the result of adopting a phonetic spelling will be the break-up of the English language. This is quite erroneous. Phonetic spelling simply represents pronunciation, and if the phonetic spelling of London English differs from that of Colonial English it can only be because the pronunciations are different; that is, because the language has *already* broken up. On the other hand, if the pronunciations are the same, the spellings will be the same, and I fail to see how an identical spelling in London and Australia can bring about a disruption.

In the present state of Biblical criticism, I rather wonder that the tower of Babel should be appealed to as evidence of *Hebrew* thought; but if the Hebrews were really so impressed with the confusion of tongues, and if phonetic spelling is really so conducive to that confusion, then let me ask: Why did the Massorites, with that story before their eyes, go and make the originally phonetic Hebrew alphabet more phonetic still by adding the finest set of vowels that has ever been used? Why, except that they knew, as Prof. Sayce and Dr. Tylor know, and the late Charles Darwin knew, that phonetic spelling is the only thing that preserves language and its history from utter decay.

JOHN FENTON

Spelling Reform Association, 8, John Street, Adelphi, W.C., August 14

Possible Sound Organs in Sphingid Pupæ

IN recently characterising the pupa of *Sphinx catalpæ*, Boisd., for my report as entomologist to the Department of Agriculture, I was struck with the occurrence on the anterior border of each of the larger movable abdominal joints (viz., abdominal joints 5, 6, and 7) of a peculiar elongate concavity, a structure not mentioned by Westwood, Burmeister, Kirby and Spence, Girard, Clemens, Harris, Graber, or any modern author whom I have been able to consult. There is an approach to it in the pupa of *Ceratomia amyntor*, and it occurs in that of *Sphinx harrisii* in similar position and form as in *S. catalpæ*. In *Macrosila* 5-*maculata* it is somewhat above the spiracles, and that on the fifth abdominal joint has a second larger ridge running around it posteriorly. It does not occur in any of the species of the genera Sesia, Thyreus, Darapsa, Deilephila, Philampelus, and Smerinthus in my collection. It has no internal connection with the respiratory or circulatory systems, and its function is probably sound-producing by friction with the posterior margin of the preceding joint. This organ may, in fact, throw some light on the method by which the noise is produced which the pupa of *Sphinx atropos* is capable of. Unfortunately, I have no pupæ of that species for examination.

I shall be glad to learn from any of your Lepidopterological readers if they are familiar with this structure on any other pupæ or know of any record of it. C. V. RILEY

Washington, D.C., U.S.A.

Meteorology of the Antarctic Region

IT is well known that on the Antarctic lands perpetual snow descends much lower than in corresponding latitudes of the northern hemisphere. The chief cause of this is, no doubt, the difference of climate due to the preponderance of land in the northern hemisphere and of water in the southern. But there is another cause, of sensible magnitude, which I have not seen mentioned. In high southern latitudes the barometer stands permanently nearly an inch lower than in corresponding northern latitudes, and this must cause a permanently lower temperature in the Antarctic regions. That is to say, a depression of an inch in the barometer corresponds to about 1000 feet of mountain ascent; and any station in the Antarctic region must therefore be as much colder than a corresponding one in the Arctic region, as if the Antarctic station stood 1000 feet higher above the sea-level than the Arctic one.

The cause of the barometric depression in the Antarctic region is probably the centrifugal force of the west winds, or "counter-trades," which, as Maury remrrks, surround the South Pole with "an everlasting cyclone on a great scale."

JOSEPH JOHN MURPHY

Old Forge, Dunmurry, Co. Antrim, August 8

RECTOR (whose appeal for help in protecting a granite boulder in his country parish we inserted in No. 663) requests us to acknowledge with many thanks the following contributions:—Saxo, 2*s*. 6*d*.; William S. Layman, 2*s*. 6*d*.; J. W. A., 5*s*.

SUN-SPOTS AND MARKREE RAINFALL

BY aid of R. Wolf's series,[1] I have been endeavouring, if possible, to trace the effect of the different state of the sun's surface, as shown by the extent of its spots, on our climate. I distributed the annual rainfall, registered here 1833-1863, into ten classes, according to the corresponding values of "the relative numbers" r, as exhibited in Table I. These relative numbers have been determined by Prof. Wolf from a discussion of the registered number of spots and groups of spots on the sun, and are supposed to be proportional to the area covered by spots on the sun's surface. The mean rainfall M, the average of the thirty-one years, is 37·254 inches. o is the rainfall regis-

[1] "En désignant par g le nombre des groupes de taches nus un jour quelconque sur le soleil, une tache isolée comptant pour un groupe; par f le nombre des taches contenue dans tous les groupes, nombre que j'estime approximativement proportionel à la surface tachetée; et par k un coefficient dépendant de l'observation et de son instrument, et déduit d'observations correspondantes, en supposant ce coefficient égal à l'unité pour mai et pour le grossissement 64 d'un *Fraunhofer* de 4 pieds, je pose: $r = k(f + 10g)$, et je nomme r le *nombre relatif* de ce jour. La moyenne de tous les nombres relatifs appartenant à la même année donne le nombre relatif de l'année." R. Wolf, Mémoire sur la Période commune à la Fréquence des Taches Salaires et à la Variation de la Déclinaison Magnetique (Memoirs of the Royal Astronomical Society, vol. xlii., 1877, Part vi).

tered during a certain year –. I tried to reduce the difference o – M (Table II.) by applying to M a constant correction, $10x$, and at the same time a correction ry proportional to the respective relative number. The equations of condition of the form—

$$10x + ry + o - M = o$$

are exhibited in Table I., the last column of which exhibits the remaining errors, v, *i.e.* the difference between the registered rainfall, o, and the calculated, $C = M - 10x - yr$, after that the quantities x and y had been obtained from the equations of condition by solving them by aid of the method of least squares. It will be remarked that v is far smaller than o – M in Table I., the average of several years, but the comparison from year to year, o – C as exhibited in Table II., shows but a small decrease in the differences. The result is—

$$\overset{\text{inches.}}{C = 34.435} + \overset{\text{inches.}}{0.04785}\, r = \overset{\text{inches.}}{37.254} + \overset{\text{inches.}}{0.04785}\,(r - 58.91).$$

TABLE I.

Years: 1800 +		Equations of condition.		v.
56, 55, 33	...	$10x + 7.4y - 3.35 = 0$	...	−0.89
43, 34, 44	...	$10x + 15.2y - 1.89 = 0$	...	+0.20
54, 57, 42	...	$10x + 22.3y - 2.87 = 0$	..	−1.12
45, 41, 53	...	$10x + 38.4y - 0.23 = 0$	...	+0.76
63, 52, 58, 35	...	$10x + 53.3y + 0.84 = 0$	...	+1.11
46, 62, 40	...	$10x + 60.8y - 1.07 = 0$	...	−1.16
51, 50, 61	...	$10x + 70.2y + 4.04 = 0$	...	+3.50
39, 59, 60	...	$10x + 89.5y + 2.52 = 0$	..	+1.06
49, 47, 38	...	$10x + 99.0y - 1.99 = 0$	...	−3.91
36, 48, 37	...	$10x + 127.0y + 3.71 = 0$	...	+0.45

TABLE II.

Year.		r.		o. inches.		o – M. inches.		o – C. inches.
1833	...	9.4	...	44.49	...	+7.24	...	+9.60
1834	...	13.3	...	36.50	...	−0.75	...	+1.42
1835	...	59.0	...	37.34	...	+0.09	...	+0.08
1836	...	119.3	...	41.39	...	+4.14	...	+1.25
1837	...	136.9	...	40.29	...	+3.04	...	−0.70
1838	...	104.1	...	31.00	...	−6.25	...	−8.41
1839	...	83.4	...	33.92	...	−3.33	...	−4.50
1840	...	61.8	...	30.77	...	−6.48	...	−6.63
1841	...	38.5	...	35.55	...	−1.70	...	−0.73
1842	...	23.0	...	33.25	...	−4.00	...	−2.30
1843	...	13.1	...	35.96	...	−1.29	...	+0.89
1844	...	19.3	...	33.63	...	−3.62	...	−1.73
1845	...	38.3	...	40.37	...	+3.12	...	+4.10
1846	...	59.6	...	37.56	...	+0.31	...	+0.28
1847	...	97.4	...	37.17	...	−0.08	...	−1.92
1848	...	124.9	...	41.22	...	+3.97	...	+0.81
1849	...	95.4	...	37.63	...	+0.38	...	−1.37
1850	...	69.8	...	37.12	...	−0.13	...	−0.65
1851	...	63.2	...	40.25	...	+3.00	...	+2.79
1852	...	52.7	...	45.72	...	+8.47	...	+8.75
1853	...	38.5	...	35.17	...	−2.08	...	−1.11
1854	...	21.0	...	34.77	...	−2.48	...	−0.67
1855	...	7.7	...	29.36	...	−7.89	...	−5.44
1856	...	5.1	...	27.87	...	−9.38	...	−6.81
1857	...	22.9	...	35.14	...	−2.11	...	−0.40
1858	...	56.2	...	34.34	...	−2.91	...	−2.79
1859	...	90.3	...	41.65	...	+4.40	...	+2.90
1860	...	94.8	...	43.74	...	+6.49	...	+4.77
1861	...	77.7	...	46.52	...	+9.27	...	+8.36
1862	...	61.0	...	40.23	...	+2.98	...	+2.88
1863	...	45.4	...	34.97	...	−2.28	...	−1.64

It should be remarked that the receiver of the guage is placed on the top of the library, 16 feet above the ground and 148 feet above mean sea-level. I have placed another guage 6 inches above the ground and 110 feet above the sea, as levelled from bench-mark on observatory wall, and have taken precautions against evaporation from this guage. By comparing the results from the two guages during the last five years, I find that the rainfall registered by aid of the upper guage must be multiplied by 1.2426 in order to indicate the rainfall at 110 feet above sea. The formula properly reduced is therefore—

$$\overset{\text{inches.}}{C = 46.292} + \overset{\text{inches.}}{0.05946}\,(r - 58.91).$$

I am only too painfully conscious that this result has been derived from insufficient data, but it might be interesting to see whether it would be confirmed by a similar discussion of a sufficiently extensive register kept at some older observatory.

The average monthly rainfalls are as follows:—

		inches.				inches.
January	...	3.451	...	July	...	3.284
February	...	2.771	...	August	..	3.599
March	...	2.485	...	September	...	3.249
April	...	2.460	...	October	...	3.881
May	...	2.026	...	November	...	3.530
June	...	3.044	...	December	...	3.474

Markree Observatory, July 17 W. DOBERCK

THE NEW REPTILE HOUSE AT THE ZOOLOGICAL SOCIETY'S GARDENS

THE present Reptile House in the Zoological Society's Gardens adjoining the Lecture Room, is an old wooden building, which in the early days of the Society was used for lions and tigers, and is now in a very bad state of repair. Besides this it is much too small for the present collection of reptiles. The cages which it contains are always over full, while the tortoises are necessarily lodged in a separate house, and the crocodiles are kept in a building properly destined to contain sloths and marsupials. Moreover, most of the compartments in the present Reptile House are accessible only from the front, which renders it inconvenient, not to say dangerous, to open them in the day-time, when the house is filled with sightseers. Under these circumstances, the Council of the Society have determined to construct an entirely new building for the better accommodation of the reptiles at the southern corner of the Gardens, and having obtained the necessary permission of H.M. First Commissioner of Works, will commence operations immediately.

The new Reptile House will be 120 feet long by 60 feet in breadth, with a large porch and double entrance at the front, and keepers' and workers' rooms in the rear. The building will be of brick with corse-hill stone dressings, the roof of iron, slated on the north slope, and provided with ample skylights on the south slope. The house will face due south. It will be fitted with fixed cages for the reptiles on the north, east, and west, leaving the south side (which will be nearly entirely of glass), available for movable cases (such as are now in use in the Insect House), for the smaller and more delicate objects. There will be a large oval pond for crocodiles in the centre of the building, and two smaller circular ponds on each side of it for other aquatic reptiles. The fixed cages, which will be from thirty to forty in number, will be fronted with plate-glass, and the only means of access to them will be from the keeper's passage in the rear, so that there will be no possibility of the animals escaping into the space occupied by the public.

The new Reptile House, will, it is expected, be completed and roofed in before Christmas, and as the hot-water apparatus will be finished by the same date, it will be possible to dry it thoroughly during the winter, so that the reptiles may be moved into their new quarters early in the ensuing summer.

The designs for the new building have been drawn by Mr. C. B. Trollope, and the contract for its erection has been undertaken by Messrs. Hannen and Holland.

The Society's collection of reptiles consists at present of 57 tortoises, 10 crocodiles, 95 lizards, and 83 snakes. Of the last-mentioned, 10 are large pythons and boas, and 14 belong to venomous species. Besides the reptiles there are 56 Batrachians living in the Gardens, which for the present at least, will be kept along with the reptiles.

There is, therefore, no fear of the new Reptile House lacking inhabitants, when ready to receive them next year.

DIFFICULT CASES OF MIMICRY

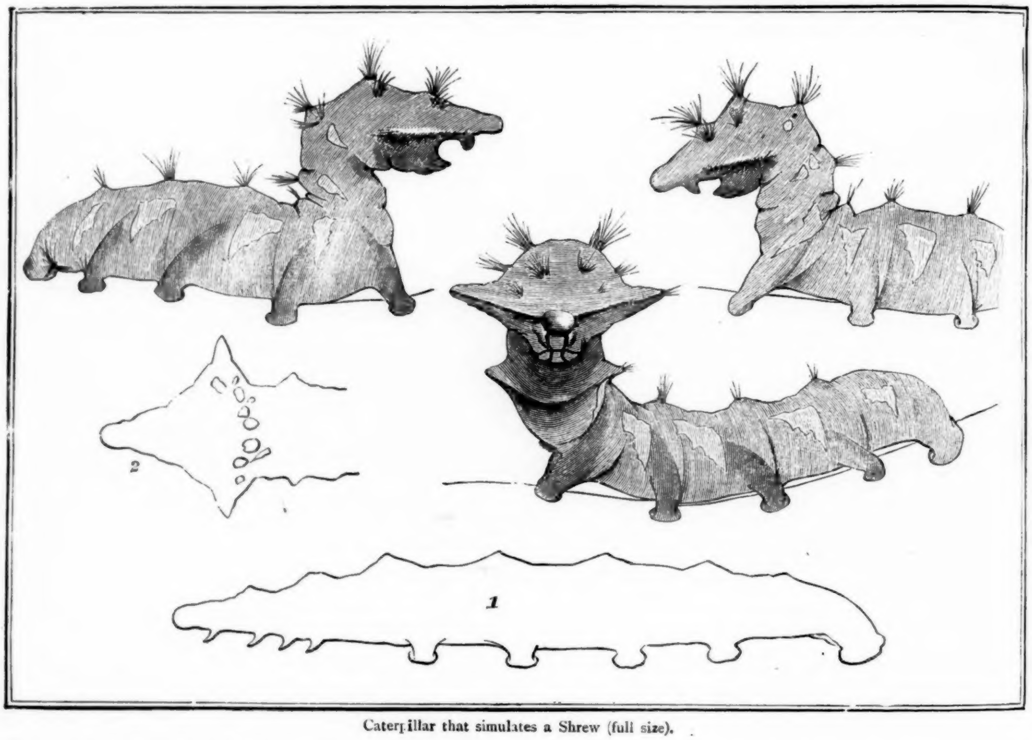
I SEE a notice regarding mimicry and simulation, by Mr. A. R. Wallace, in NATURE, vol. xxvi. p. 86, and beg to forward the case of a caterpillar mimicking a shrew, as a peculiar instance of this curious law.

Here we see the insect unconsciously simulating the very animal that most likely feeds on itself, or at least an insectivorous mammal. Passing through a dense forest near a path, I suddenly came on the caterpillar, at about five feet from the ground, on a stout creeper, and of course mistook it for a shrew. Its remaining, and not running off, induced me to look closer, when I saw the green markings, and at once secured the prize, and, after making a sketch or two, put it in my "hatching" cage; unfortunately, I could not find what it fed on, and after spinning a pale greenish cocoon, it died. The natives did not seem to know it. When moving along, it does so as other caterpillars, as seen in the outline 1, of which 2 is plan of the head. If suddenly disturbed, it at once strikes the peculiar pose, as seen in the sketches, and retains it for some time.

The general colour is a neutral to brown-grey, beautifully marked, and which I have not attempted to imitate; the general appearance is dark, except where the greenish-yellow spots occur. It is the first case I know where a caterpillar mimics a vertebrate animal. The cases are almost innumerable out here, where insects mimic each other and similar or different kinds, or leaves, seeds, flowers, sticks, pieces of grass or clay, &c., &c.; but we see it also in many other cases, not always protective, though invaluable to the animal or the insect. The tiger has one call, when hunting, so like the loud whistle of the Samber (deer) that only an expert and old resident can tell the difference. The deer, if within range, *run to it*, and I have myself shot a Samber at twenty yards that dashed up on my whistling loudly, with a leaf; unfortunately, native shikaries are only too expert at this. Again, the eye and nose lumps of a crocodile are so like lumps of foam that I have often drifted past close to one in my *Rob Roy*, and only found it out by the lump of foam quietly and suddenly *sinking* below the surface of the muddy water. In the case of the tiger the simulation was by sound, to enable it to get food; in that of the crocodile the same end is gained by simulation of appearance, enabling the animal to drift close to prey without alarming it.

S. E. PEAL

Asam, June 25



Caterpillar that simulates a Shrew (full size).

THE WASHBURN CHRONOGRAPH

THE article on the Brussels Chronograph (NATURE, vol. xxvi. p. 107) induces me to send a brief description of the chronograph of this observatory, which may be taken as representing the form usually adopted by the best American makers, Alvan Clark and Sons, Fauth and Co., Stackpole and Brothers, &c. The accompanying engraving gives a good general idea of it. The scale may be obtained by remembering that the iron base plate is $21\frac{1}{2}$ inches by $11\frac{1}{4}$ inches. The barrel is 14 inches long by 7 inches in diameter. The paper used is $23\frac{1}{8}$ inches by 13 inches which provides for a lap at the line of junction. There is room for the observations of two hours and forty minutes. The weight employed is fifteen pounds, and usually a double pulley is used to diminish the fall.

The chronograph can be wound while it is going, with-

out affecting its rate. The barrel can be taken out of its Ys if desired, or one end of the barrel can be lifted by a small lever, so that it can be turned around to put on or take off a fresh sheet of paper. In practice several sheets of paper are put on at a time, so that the last one has simply to be removed when it is filled, and the pen-carriage moved back (to the right) to continue the record. This can be done without stopping the chronograph.

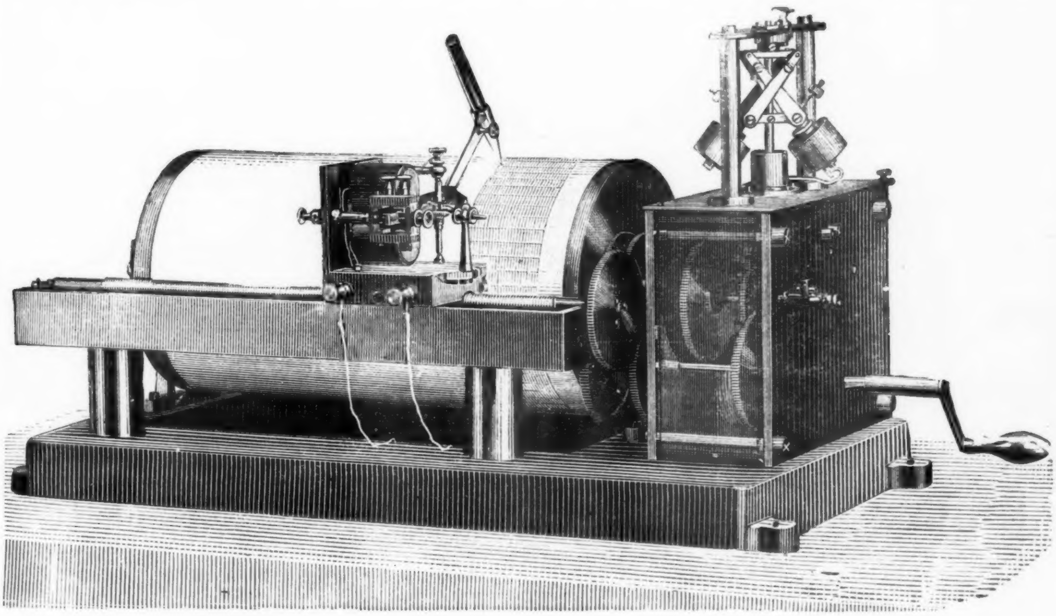
A second of time is 0·36 inches in length, in the usual adjustment. The governor is a double conical pendulum, acted on directly by the weight. It thus tends always to run too fast, as it runs faster and faster, the pendulum bobs fly out, and finally strike the point of a horizontal hook shown in the drawing. This hook is attached to a little cylinder of brass embracing the vertical axis (also shown), and when the hook is touched by the pendulum bob (as it is shown in the cut), the hook and the brass cylinder are carried about the axis through a certain angle. The work thus done diminishes the speed of the pendulum, which falls in towards the axis slightly. In this way the governor and also the barrel rotate alternately a little faster and a little slower than the desired mean rate, but these variations are vanishingly small and of no account whatever in astronomical work. The pendulums strike the hook on the average from sixty to ninety times per minute.

The pen-carriage is nothing but an electromagnet mounted on a frame, which is driven by an endless screw from right to left in the cut. The carriage may also be lifted by the hand and moved in either direction. This is a great convenience in certain kinds of work, such as comparing a number of clocks together. The record for each clock can be separated from that of every other clock by a blank space.

The pen is of glass, filled with a thick ink made according to the following formula which is used at the Naval Observatory. This ink does not freeze in winter weather.

Water	4 fluid ounces.
Alcohol	2 ,,
Concentrated glycerine	1 fluid drachm.
Crystallised Aniline Blue	40 grains.

Filter very thoroughly and draw off for use through a stop-



cock. A common stylo-graphic pen, if held nearly vertical and weighted with a little piece of lead, is nearly as good as the glass pen, and somewhat cleaner.

The signals from the clock and observing key are received through the two flexible wires shown in the cut. These signals can be repeated, by connections to screw-posts, on the pen-carriage.

The whole machine is light and portable. It takes, say, fifteen minutes to move it from one room to another. It can be worked equally well with a break or a make-circuit. Its price is 325·00 dollars. The makers of our chronograph are Fauth and Co., Washington, D.C., but the design is that adopted by the Clarks.

The first *double* conical pendulum of this kind was made by Dr. Henry Draper, and applied to the driving-clock of his photographic telescopes. The first governor on this principle was adopted by Alvan Clark and Sons, for driving the heliostats used in the United States Transit of Venus Expedition of 1874. These governors had, however, only a single pendulum, and not two crossed pendulums, as in the cut. I am induced to send you this brief account of a simple and useful device which has had a thorough trial of 31 years (it was exhibited by G. P. Bond at the Crystal Palace in 1851), which is always satisfactory; which never gets out of order; because it is a standing wonder to us, on this side of the water, why the expensive and complicated double-pen chronographs continue to be made and used in England, and on the Continent. The inclosed sheet, which is selected absolutely at random from a pile of such records, will show the kind of work these machines will do; and all the questions which have been agitated with regard to the relative accuracy of one and two pen-chronographs, seem to me to have been practically settled by the observations made at our principal observatories for a score of years past. I need only mention the longitude campaigns of our Coast Survey, of the Naval Observatory, of the Army Engineers, and the standard work of the Transit circles of Washington and Harvard College, in this connection.

I am sure that it only needs a trial of the form indicated to prove its superiority in every respect for astronomical purposes. All objectors on the score of accuracy, &c., should refer to the *Annals* of the Harvard College Observatory, vol. i., part ii., pp. xxxiv., where they will find what seems a sufficient answer.

EDWARD S. HOLDEN

Washburn Observatory, University of Wisconsin, Madison, June 30

THE LIMIT OF THE LIQUID STATE OF MATTER

THE conditions under which an investigation is carried out often predetermine the conclusions to be drawn from the observations made. That this has been the case with the observations made upon the upper confines of the liquid state, there is now ample evidence to show. When Cagniard de Latour, on heating liquids in sealed tubes, noticed the disappearance of the liquid surface, he came to the conclusion that the liquid state had ceased to be possible, and that the substance had passed into the gaseous state. But Latour had no means of varying the volume of his liquid to observe whether or not increase of pressure might again induce liquefaction. This defect was removed by Dr. Andrews, who constructed the well-known apparatus for varying the volume by means of a screw. And it is to the work performed with this apparatus that the above remark is applied. By two modes of observation Dr. Andrews arrived at the conclusion that the liquid and gaseous states of matter were continuous. The experiments being conducted in transparent glass tubes, the appearance of the contained fluid constituted one mode, and the registration of the pressure constituted the other. *Neither of these methods could by the necessities of the case give any aid in determining the state of matter.* Dr. Andrews's method of demonstrating the continuity, by passing from a lower to a higher temperature under a pressure which prevented the formation of vapour, ensured the homogeneity of the fluid under examination, and precluded the existence of a visible liquid surface; and as liquid and gas are equally transparent, no tidings of the state of the fluid under examination could come to him by observations of its appearance. How did Dr. Andrews tell when his tubes contained liquid? By lowering the pressure till a meniscus was seen. *Then the formation of a meniscus is the only test of the liquid state.* Dr. Andrews then obliterated the only ocular test of the fluid's condition by increasing the pressure, and raised the temperature till on again reducing the pressure no meniscus was formed, showing the fluid to be gaseous, and he then declared that no sudden change of state had occurred—that is to say, that it was impossible to say that the fluid was either liquid or gaseous, but that it had probably passed through an intermediate state. Of course a change of state had taken place, and if we only reflect that the change from cohesion to repulsion is caused by the thermal velocity of the molecules, and not by the number of them in a space, the change should depend upon temperature and not upon pressure.

The characteristic property of the liquid state is then the possession of cohesion sufficient to form a surface, or simply surface tension; and could this property be retained in a visible form at all pressures, the existence of the continuity enunciated by Andrews could be put to a crucial test. By compressing hydrogen over various liquids in which it is insoluble, I was enabled to carry the above proposition into effect, and after several hundreds of experiments, detailed in a paper read before the Royal Society, the conclusion was arrived at that the two states are not more continuous than are the solid and liquid states, but are separated by an isothermal passing through the critical point. In fact by Latour's or Andrews's method, where the liquid was in contact with its own vapour, the critical point is the only place where the direct passage from liquid to gas is visible, but the employment of hydrogen for retaining a free surface enables us to observe the passage at any pressure, and it takes place as suddenly at 200 atmospheres pressure as at the critical pressure. Thus the critical point is the termination of an isothermal line, which is the limit of the liquid state.

As to the other mode employed by Andrews—namely, pressure—continuity of pressure does not prove continuity of state. If it did the continuity of the solid and liquid states could easily be proven. In fact, the irregularities observed by Andrews in the vicinity of the critical point rather lend support to the views that a change of state takes place there.

We may state the change thus:—The cohesion of the liquid state is weakened as the thermal motion increases, till the repulsion is in excess of the attraction, and the gaseous state ensues. The evidence I have collected from capillary phenomenon in the paper above referred to proves this to be the case, and shows that pressure has no effect in altering the occurrence of the phenomenon. Thus we are led to the conclusion, that so far from the liquid and gaseous states of matter being continuous and indistinguishable, the liquid limit or "absolute boiling point" *is the only fixed point among the properties of matter.* The freezing point can be altered by pressure, and besides, many bodies like ethyl alcohol may have no freezing point, probably becoming more and more viscous till absolute zero is reached. But all substances may be made to pass into the gaseous state, and even delicate compounds may be rendered gaseous without decomposition when under sufficient pressure. We see then that this important change of state, for which I propose the name Cohesion Limit, and which till lately was supposed to have no existence, is in reality the only fixed point in the relations of the states of matter, being determined by temperature alone.

J. B. HANNAY

INTERNATIONAL METEOROLOGY

THE second meeting of the International Meteorological Committee took place at Copenhagen, August 1-5 inclusive. All the Members were present, except Prof. Cantoni, who had resigned his seat on the Committee on account of health. Prof. Tacchini was unanimously elected in his place. The following brief account of the more important of their proceedings is in the numerical order in which the respective subjects were discussed.—

It was resolved—

(*a*) To organise an exhibition, in connection with the International Fisheries Exhibition, London, of the methods and apparatus used in different countries for giving weather intelligence and storm warnings to the coasts, and of the instruments, &c., used in the study of ocean meteorology.

(*b*) To issue a circular to all existing organisations, requesting them to supply data as to their condition and operations up to the end of the current year.

(*c*) To request the several institutions to be more precise in the information published by them as to the hour of occurrence of rain and other phenomena.

(*d*) To request all institutions to append to their Daily Bulletins, Monthly Sheets giving the mean results for the month, in the same way as the London Office has done since 1880.

(*e*) To request all institutions to furnish particulars of any stations which may exist in distant localities, especially in the Torrid Zone, South America, and the Islands of the Pacific, at least during the period of the International Polar Observations, and to publish the names of such stations in the Polar Bulletin issued by Prof. Wild.

(*f*) To express approval of the plan proposed by Capt. Hoffmeyer and Dr. Neumayer to publish daily synoptic

charts of the Atlantic Ocean, with an explanatory text, at the cost of the respective institutions of Copenhagen and Hamburg, and to recommend other institutions to contribute materials for the work, if they can.

(*g*) M. Tietgens, Chairman of the Great Northern Telegraph Company, submitted to the Committee a plan for a cable to connect Iceland and the Faroes with Europe, the expense to be met by the receipts from meteorological telegrams. The Committee, while recognizing the very great importance which information coming from Iceland and the Faroes must possess in relation to the issue of storm warnings and forecasts in Europe, felt that they were not in a position to express an opinion on the practical execution of the project.

(*h*) The Sub-Committee nominated at Berne (MM. Mascart and Wild) submitted specimens of their proposed International Reduction Tables. It was resolved to print a full page of each of these tables, with explanations, and submit them to meteorologists for their opinion, with the view of subsequently publishing the tables by means of subscriptions from the different institutes.

(*i*) M. van Rysselberghe's proposal to communicate by wire the indications of his instruments at out stations to central offices was considered, and that gentleman was requested to draw up and publish a detailed scheme for its execution.

(*j*) A Committee was nominated, consisting of M. de Brito Capello, Rev. Clement Ley, and Prof. Hildebrandsson, to draw up a scheme of instructions for the observations of "cirrus" clouds.

(*k*) It was resolved that the prospects of the preparation of a general catalogue of Meteorological Bibliography were not favourable to its execution, and that the only action for the Committee to take was to invite the heads of the different institutes to prepare catalogues of the meteorological literature of their respective countries.

The Members of the Committee were most hospitably entertained during their stay in Copenhagen. They were honoured with an invitation to dine with the King on the 5th inst., and on the following day an excursion was organised for them by the Marine Ministry to Friederichsborg and Elsinore, which was fortunately favoured with fine weather.

THE SMOKE ABATEMENT INSTITUTE

AT a meeting held at Grosvenor House, under the presidency of His Grace the Duke of Westminster, K.G., on July 14, at which the Reports of the recent Exhibitions in London and Manchester were presented, and the medals distributed to successful exhibitors, the following resolution was moved by Prof. Abel, C.B., F.R.S., seconded by Mr. J. Norman Lockyer, F.R.S., and carried unanimously:—

"That it is desirable that the work thus far carried on by the Smoke Abatement Committee be continued, and for that purpose a Smoke Abatement Institute be formed."

The chief objects of the proposed Association will be:—

(*a*) To promote the abatement of coal smoke and other noxious products of combustion in cities and other places, in order to render the atmosphere as pure and as pervious to sunlight as practicable.

(*b*) To check the present serious waste of coal, and the direct and indirect loss and damage accompanying the over-production of smoke and noxious products of combustion.

Extended powers will be taken for carrying out the objects of the Association by the following, among other means, viz.:—

1. By promoting and encouraging the better and more economical use of coal and coal products, the selection of suitable fuel, and the general improvement in producing, applying, and using heat and light for domestic and industrial purposes.

2. By conducting tests of smoke-preventing apparatus and fuels in manufacturing towns as well as in London.

3. By reporting on tests, granting awards for approved fuels, methods, or apparatus; by lectures, printing, publishing, and circulating statistics and other information for the guidance of local authorities, inventors, manufacturers, and others; and by giving instruction to workmen, servants and others in the use of new appliances, &c.

The terms of membership are one guinea per annum, or such larger sum as members may voluntarily choose to contribute. No liability will be incurred by becoming a member beyond a guarantee of one guinea, payable, if required, in the event of the termination of the Association; and any member can withdraw from the Association by giving notice of his wish to do so.

THE COLOURS OF FLOWERS, AS ILLUSTRATED BY THE BRITISH FLORA[1]

IV.—*Degeneration*

THE cases already detailed lead us gradually up to the consideration of those very degenerate flowers whose structure has become completely debased, and especially of those which have green perianths instead of coloured corollas. As a rule, evolutionists have taken it for granted that green flowers were the earliest of any, and that from them the coloured types have been derived by insect selection. But if the principles laid down so far be correct, then it is obvious that, since all petals were originally yellow, green petals must be degraded, or at least altered types. Of course, the flowers of gymnosperms (in their blossoming stage) are mostly composed of green scales or leaves; and so it no doubt remains true that all flowers are ultimately descended from green, or greenish, ancestors. But if petals are by origin modified stamens, it will follow that all corollas at least were once coloured; and we shall probably see reason in the sequel to extend the principle to all perianths whatsoever. Without insisting upon the rule too dogmatically, so as to embrace every kind of angiosperm, we may, with some confidence, assert that wherever a flower possesses a rudiment of a perianth in any form, it is descended from coloured and entomophilous ancestors.

The Composites are, perhaps, in some respects, the very highest family of entomophilous flowers now existing on the earth. Their very structure implies the long and active co-operation of insect fertilisers. They could not otherwise have acquired the tubular form, the united corolla, the sheathed anthers, the compound heads of many-clustered florets. That originally green flowers could attain to this stage of development, and yet remain green, is simply inconceivable. But the Composites contain also some of the most degraded flower types in all nature. Beginning with such forms as the common groundsel (*Senecio vulgaris*), which has an inconspicuous yellow rayless head, specially adapted to self-fertilisation, we go on to plants like the *Artemisias*, with small greenish florets, which have taken, or are taking, to wind-fertilisation. Still more degraded are the *Antennarias*, *Gnaphaliums*, and *Filagos*, whose mode of fertilisation is problematical. And at the very bottom of the scale we get the little green *Xanthium*; so degenerate a form that its connection with the other Composites can only be traced by means of several intermediate exotics, in every stage of progressive degradation. Such conclusive examples clearly show us that green flowers may occur as products of degradation even in the most advanced families.

Adoxa moschatellina is another excellent specimen of a green corollifloral blossom. This pretty little plant is closely allied to the honeysuckles and ivies; but it has somehow acquired a light green corolla, in place of a white or pink one. It is still entomophilous, and scantily secretes honey, so that the reason of the change cannot be

[1] Continued from p. 350.

immediately pointed out. Perhaps its very inconspicuousness saves it from the obtrusive visits of undesirable insect guests. The flowers of *Hedera helix*, common ivy, are also yellowish green. In the allied family of *Umbelliferæ* many flowers have declined to similar greenish tints; but this can hardly be their primitive colour, as they have an inferior ovary, which marks high development.

FIG. 27.

FIG. 28.

FIG. 27.—Single floret of *Poterium sanguisorba*, green and anemophilous. FIG. 28.—Single floret of *Sanguisorba officinalis*, purple and entomophilous.

Smyrnium olusatrum in this family, and *Chrysosplenium* among the *Saxifragaceæ*, exhibit very well the steps by which green corollas or perianths may be produced from originally white or yellow flowers. Their high structural development obviously negatives the notion that they are primitive green flowers; and we

FIG. 29.—Single blossom of South European *Fraxinus ornus*, flowering ash, with calyx and four-lobed white corolla.

must necessarily conclude that they have become green for some special functional purpose of their own.

The orchids themselves, that most specialised of entomophilous types, show us other examples of flowers which have become more or less green; such as *Malaxis paludosa*, which has a yellowish tinge; *Liparis loeselii*, also

FIG. 30.—Three forms of naked flowers of British ash, *Fraxinus excelsior*, without calyx or corolla.

yellowish; *Epipactis latifolia*, greenish brown; *Listera ovata*, grass-green; *Habenaria viridis*, yellowish green; and *Herminium monorchis*, pale greenish yellow. Why these highly-developed entomophilous blossoms should have found green suit them better than white, pink, or purple, it would be hard to say; but the fact remains indisputable; and it would be almost inconceivable that flowers of so high a type should have remained green all through the various stages of their long previous development. We may confidently set them down as products of incipient degeneration.

Among polypetalous flowers we get some equally interesting facts. *Helleborus viridis*, a doubtfully English ranunculaceous plant, has small green petals, employed as nectaries, and concealed by the large green sepals. It is entomophilous, and much visited by insects. Instead of being one of the least-developed *Ranunculaceæ*, however, it is one of the most advanced and highly differentiated types. In the lily family, again, the onion genus

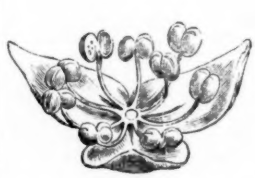


FIG. 31.

FIG. 32.

FIG. 31.—Single male flower of dog's mercury, green. FIG. 32.—Single female flower of dog's mercury, green.

(*Allium*) is a small, and often degraded, group, whose more retrograde members produce green in place of purple or white flowers. In *Allium vineale*, and some others, the flowers often degenerate so far as to become small caducous bulbs. Here, degeneration is the only possible solution of the problem presented by the facts.

More frequently, however, reversion to wind-fertilisation (probably the primitive habit of all flowering plants) has produced green blossoms among angiosperms. This may result in two or three distinct ways. Either the corolla may become dwarfed and inconspicuous, or it may coalesce with the sepals or calyx-tube, or it may

FIG. 33.

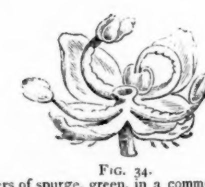


FIG. 34.

FIG. 33.—Cluster of male and female flowers of spurge, green, in a common involucre: the male flowers reduced to a single stamen each, jointed where the filament joins the peduncle. FIG. 34.—Male flower of nettle, green, the stamens opposite the sepals.

cease to be produced altogether. We may take the plaintains (*Plantago*) as a good example of the first-named case. Here we have tubular florets with four corolla-lobes, apparently descended from some form not unlike *Veronica* (though with four cells to the ovary) but immensely degraded. The corolla is thin and scarious, and its lobes are tucked away at the sides, so as not to interfere with the stamens and style. These, again, as in most wind-fertilised plants, hang out freely to the breeze; so that the whole spike when flowering shows no signs of a corolla from without, but seems to consist entirely of scales, stamens, and styles, just like a sedge or

grass-plant. It is impossible, however, to examine the functionless corolla without coming to the conclusion that *Plantago* must be descended from an entomophilous ancestor. Indeed, *P. media* still to some extent lays itself out to attract small flies, by which it is even now often visited and fertilised.

The *Rosaceæ* offer some good examples of green flowers in which the petals have become quite extinct. Some of them are entomophilous, and some anemophilous. *Alchemilla vulgaris* (lady's mantle) is one of the former class. It is a degraded representative of the same group as agrimony; but it has lost its petals altogether. That it is a late, not a primitive form, is shown by its very re-

FIG. 35.

FIG. 36.

FIG. 37.

FIG. 35.—Female flower of willow, reduced to a scale and an ovary. FIG. 36.—Male flower of willow, reduced to a scale and two stamens. FIG. 37.—Naked flowers of the Arum, each consisting of a single ovary or a few naked stamens.

duced carpels, and its small number of stamens. *Alchemilla arvensis* (parsley-piert) is an extremely debased moss-like descendant of some similar ancestor. It has tiny green petalless axillary flowers, self-fertilised, but occasionally visited by minute insects. Not far from these may be placed *Poterium sanguisorba* (Fig. 27), another degraded type, which has become anemophilous. This flower, too, is green, and has no petals; it usually possesses but one carpel, and it is altogether a clearly debased bisexual form. Its stamens are numerous, and they hang out to the wind, so do also the feathery stigmas in the female flowers, to catch the pollen from neighbouring heads. But the closely-allied *Sanguisorba officinalis* (Fig. 28) is evidently an entomophilous variation on the same

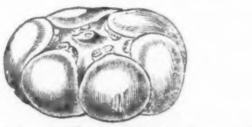


FIG. 38.—Single flower of *Acorus*, with three sepals, three petals, six stamens, and an ovary.

ancestral form; for it resembles *Poterium* in every respect except in its flowers, which have very few stamens, inclosed in the purple calyx-tube. This interesting case shows us that when a flower has once lost its petals and become anemophilous, it cannot re-develop them if it reverts to insect fertilisation, but must acquire a coloured calyx instead. The same lesson is perhaps elsewhere enforced by *Glaux maritima* among the *Primulaceæ*, and by *Clematis* among the *Ranunculaceæ*.

Mr. Darwin remarks that anemophilous flowers never possess a gaily-coloured corolla. The reason is clear. Such an adjunct could only result in the attraction of stray insects, which would uselessly eat up the pollen, and so do harm to the plant. Hence, when flowers revert to wind-fertilisation, both disuse and natural selection cause them to lose their petals, and become simply green.

In practice, however, it is often hard to distinguish between the casually entomophilous, the self-fertilised, and the really anemophilous species; and they are so intermixed that it may perhaps be best to consider them together. For example, the common ash (*Fraxinus excelsior*) belongs to a gamopetalous family, the *Oleaceæ*,

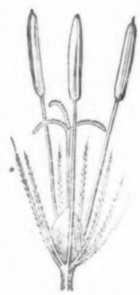


FIG. 39.

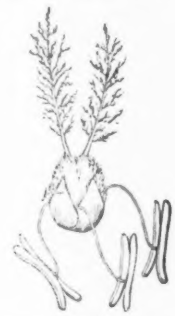


FIG. 40.

FIG. 39.—Flower of *Scirpus*, a sedge, with hypogynous bristles representing the calyx and corolla. FIG. 40.—Flower of a grass, with calyx removed, showing two lodicules or rudimentary petals, three stamens, and an ovary with two stigmas.

and is closely related to the white privet (*Ligustrum vulgare*), which has conspicuous white flowers. But many large trees, owing, perhaps, to their long life, and consequent less necessity for producing many seeds, tend to lose their petals; and this is remarkably the case among the olive group. The shrubby species have usually flowers with a four-lobed corolla; and so have many of the southern arboreal forms (Fig. 29); but the northern trees, like our ash, have lost both calyx and corolla altogether, each naked flower consisting only of

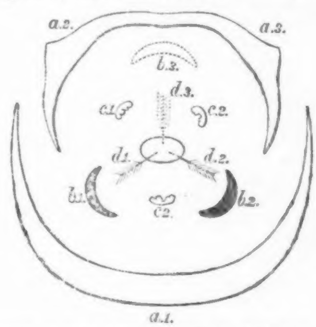


FIG. 41.—Diagram of grass flower, showing its relation to a lily: *a*, the calyx, represented by a_1, the flowering glume or outer palea, and a_2 and a_3, the inner palea, composed of two connate sepals; b_1 the corolla, represented by b_1 and b_2, the lodicules, b_3 the third petal, being obsolete; c_1 the stamens; d_1 the pistil, d_1 and d_2 the existing stigmas, d_3 being obsolete. The whole flower is thus abortively developed on the inner side next the axis.

two stamens, with a single ovary between them (Fig. 30). In appearance their blossoms seem of much the same sort as the wind-fertilised catkins and oak-kinds. Nevertheless, they are entomophilous, for their pollen, their arrangement in large masses, and their dark purple colour, sufficiently serve to entice numerous insects.

The spurges (*Euphorbiaceæ*) are a very interesting family of the same sort, exhibiting every gradation from perfect corolliferous blossoms to the most degraded flowers in all nature. Our English species have no true petals; but some exotic forms are truly dichlamydeous;

and from them we can trace a gradual decline, through plants like dog's mercury (*Mercurialis perennis*), which has a green calyx, but no corolla (Figs. 31 and 32), to very degenerate green blossoms like our own spurges (*Euphorbia*), which consist of several extremely simplified flowers, collected together in a common involucre. Each separate male floret is here reduced to a single stamen, raised on a short peduncle, and with a distinct joint at the spot where the petals once stood (Fig. 33). It is worthy of notice, too, that when these degenerate, but still entomophilous, green flowers have found it desirable to attract insects by developing new coloured surfaces in place of the lost corolla, they have not done so by producing a fresh set of petals, but have acquired coloured bracts or involucres instead, as in the well-known *Iatrophas* and *Poinsettias* of our hot-houses. This instance is exactly analogous to that of the *Sanguisorba*. It tends to show that petals are not developed from bracts, but from altered stamens.

From cases like these we go down insensibly through all the ranks of the dicotyledonous *Monochlamydæ*. In the *Paronychiaceæ*, for example, we get an order closely allied to the *Caryophyllaceæ* (especially to *Polycarpon*); and in one genus (*Corrigiola*) the flowers have small white petals, which certainly aid in attracting insects. But in *Herniaria* the flowers are quite green, and the petals are reduced to five small filaments, thus partially reverting to their presumed original character as stamens. In *Scleranthus* the filaments are often wanting, and in some exotic species altogether so. The *Amarantaceæ*, unrepresented in Britain, approach the last-named family very nearly, but have the petals altogether obsolete; and in many cases, such as Prince's feather (*Amaranthus hypochondriacus*) and Love-lies-bleeding (*A. caudatus*), the calyx becomes scarious and brightly coloured. The *Chenopodiaceæ* are other near relations, in which also the petals are quite obsolete; and in most of them the perianth (or calyx) is green. In *Salicornia* it has become so embedded in the succulent leafless stem as to be almost indistinguishable. The *Polygonaceæ*, on the other hand, are a group of plants, allied to *Chenopodiaceæ*, but with a row of degraded petals, and a strong tendency to produce coloured perianths, analogous to that which we observed in *Sanguisorba*. The flowers of *Rumex*, the docks, are sometimes green, sometimes red; those of *Polygonum* are pale-green, white, or pink. *Rumex* is sometimes, *Polygonum* constantly, fertilised by insects.

There remain doubtful, then, among green Dicotyledons, only the highly anemophilous families, like the nettles (*Urticaceæ*), and the catkin-bearing trees (*Amentiferæ*). The former have a well-developed calyx, at least to the male flowers (Fig. 34), and it is difficult to see how any one who compares them with *Scleranthus* or *Mercurialis*, known descendants of petaliferous forms, can doubt that they too are degenerate types. Indeed, the mere fact that the stamens are opposite to the lobes of the calyx, instead of alternate with them, in itself shows that a petal-whorl has been suppressed; as is likewise the case in the goose-foots and many other doubtful instances.

As to the *Amentiferæ*, *Cupuliferæ*, and other catkin-bearers, at first sight we might suppose them to be primitive green anemophilous orders. But on closer consideration, we may see grounds for believing that they are really degenerate descendants of entomophilous plants. In the alder (*Alnus*) the male catkins consist of clustered flowers, three together under a bract, each containing a four-lobed perianth, with four stamens within. These little florets exactly resemble, on a smaller scale, those of the nettle; and the stamens here, again, are opposite to the calyx-lobes, which of course implies the suppression of a corolla. In the beech (*Betula*) the three florets under each bract are loosely and irregularly arranged; and in the male hornbeam (*Carpinus*) and hazel (*Corylus*) the perianth is wholly obsolete. All these are probably quite anemophilous. The willows (*Salix*), on the other hand, have become once more entomophilous (Figs. 35 and 36); and they are much visited by bees, which obtain honey from the small glands between the florets and the axis. Degenerate as these last-named species undoubtedly are, they may be connected by a regular line of illustrative examples (not genetically) through the beech, alder, nettle, goosefoot, *Scleranthus*, *Herniaria*, and *Corrigiola*, with such perfect petaliferous types as the pinks, and ultimately the buttercups.

Among Monocotyledons, the very degraded little entomophilous flowers of the *Arum* (Fig. 37), enclosed in their green spathe, are often spoken of as though they represented a primitive type. In reality, however, they are degenerate dichlamydeous blossoms, linked to the lilies by *Acorus* (Fig. 38), which has numerous hermaphrodite flowers, each with a perianth of six scales, two rows of stamens, and a two-celled or three-celled ovary. Here, again, the green flower is obviously of late date.

What, then, are we to say about the anemophilous Monocotyledons, the great families of the sedges and grasses? Surely these, at least, are primitive green wind-fertilised flowers. Dogmatically to assert the contrary would, indeed, be rash with our existing knowledge; yet we may see some reason for believing that even these highly anemophilous types are degenerate descendants of showy petaliferous blossoms. For, if the origin here assigned to petals be correct, it becomes clear that the *Juncaceæ*, or rushes, are only *Liliaceæ* in which the perianth has become dry and scarious. Some rushes, such as *Luzula*, approach very closely in general character to the grasses; and they also show themselves to be higher types by the further development of the ovary, and the decreased number of seeds. *Eriocaulon* and the *Restiaceæ* give us a further step towards the grass-like or sedge-like character. Some of the *Cyperaceæ* show apparent relics of a perianth in the bristles which surround the ovary, especially in *Scirpus* (Fig. 39); and perhaps the perigynium of *Carex* may represent a tubular perianth, though this is far more doubtful. In the grasses (*Gramineæ*) the perianth is either altogether obsolete, or else is reduced to the paleæ with the hypogynous scales or lodicules (Fig. 40). According to the most probable view, the two paleæ represent the calyx (for the inner palea exhibits rudiments of two sepals, thus making up, with the outer palea, a single trinary whorl); while the lodicules represent two of the petals, the third (the inner one) being usually obsolete (Fig. 41). It is fully developed, however, in the bamboo. The connection is here less clearly traceable than in the *Amentiferæ*, but it is still quite distinct enough to suggest at least the possibility that even grasses and sedges are ultimately derived from entomophilous flowers.

Thus we are led, at last, to the somewhat unexpected conclusion that anemophilous angiosperms are later in development than entomophilous angiosperms, and are derived from them. Though the earliest flowering plants —the pines, cycads, and other gymnosperms—were undoubtedly anemophilous from the first, yet the probability seems to be that all angiosperms were originally entomophilous, and that certain degenerate types have taken later on either to self-fertilisation, or to fertilisation by means of the wind. Why this apparently retrograde change has proved beneficial to them it would be impossible properly to inquire here. We must content ourselves with noting that such degraded green flowers fall for the most part under one or other of four heads: (1) dwarfed or weedy forms; (2) submerged or aquatic forms; (3) forest trees; (4) grass-like or plaintain-like plants of the open wind-swept plains. That there are *no* primitive families of green or anemophilous angiosperms, it might perhaps be rash and premature to assert; but at least we may assume as very probable the principle that

wherever green flowers possess any perianth, or the relic or rudiment of any perianth, or are genetically connected with perianth-bearing allies, they have once possessed coloured insect-attracting corollas. In short, green flowers seem always (except in gymnosperms) to be the degenerate descendants of blue, yellow, white, or red ones.

GRANT ALLEN

THE INSTITUTION OF MECHANICAL ENGINEERS

THE town of Leeds is this year the place of the summer meeting of the above institution. This meeting, which commenced last Tuesday, has brought together a large number of engineers from all parts, who received a cordial welcome from the Mayor and a local committee, and have already gone through the greater portion of a very interesting programme. The president's address, as well as the papers read in the mornings, not less than the varied nature of the works thrown open in the afternoons, show the increasing connection of the engineer with the progress of civilisation and the comforts of daily life. Perhaps no better example of this could be found than in the town of Leeds. It is not necessary, and certainly it would not be very easy, to detail all the varied productions of Leeds, in which the engineer now plays an indispensable part. One or two interesting instances may, however, be cited from one of two papers read, to show to what extent manual labour is being replaced by the application of machinery.

As late as 1857 nearly all the clothing in Leeds was hand-made. At the present time a machine like a band-saw, but with a knife-edge, is employed to cut out the clothes. Some twenty-five pieces of double-cloth laid on each other are thus cut out at once. The parts are then sewn at the rate of from 700 to 2000 stitches a minute, and finally are ironed by a machine. Indeed, the several processes of cutting out, sewing together, binding, braiding, putting in sleeves, sewing on buttons, making button-holes, and ironing, are all done by machinery. The result is that between three and four million garments are annually made in Leeds alone. In the hat and cap industry, machinery is very largely used, the production being as much as 70,000 dozen per week. The manufacture of boots and shoes is carried on almost entirely by machinery, and though each boot passes through the hands of from six to twelve persons, such an article can be completely made in half an hour, from one to two million pairs of boots are being thus annually produced. The saving of manual labour, as seen by the above facts, presents a striking contrast to its waste as shown in the gigantic structures of the East; but, as the President in his address remarked, there is a reverse to the medal. The smoke nuisance yet overshadows much good work (in few places more than in Leeds), when it is admitted that it is altogether inexcusable, and cannot be too severely dealt with. Science and art have practically overcome it; and experience enables many to assert that money can be profitably laid out and yield good interest in the abatement of this unpardonable nuisance. It is to be hoped that one result of these meetings will be to do all that is possible that posterity may *not* "assuredly lay its finger upon the great blot of waste, and stigmatise our age as the Black Age, which has spoilt by careless, unnecessary, and selfish emissions of smoke and noxious gases, many a noble town and many a lovely spot on earth."

H. S. H. S.

PROFESSOR HAECKEL IN CEYLON[1]

AFTER a fortnight devoted to the enjoyment of all that was new and strange in life in Ceylon, a fortnight fruitful in result to so shrewd and ardent an observer of nature and mankind, Professor Haeckel betook himself in earnest to the real object of his journey and looked about for the most favourable spot at which to conduct his zoological investigations. These were to be confined to that class of animal life which has been the object of Professor Haeckel's special study, namely, the Radiata, including star-fish, jelly-fish, etc, as well as corals, madrepores and other polypi. He hoped to make acquaintance with many new forms developed under the varying conditions of climate and coast formation and his letter in the August number of the *Rundschau* opens with a brief and succinct account of what these conditions are: "The conditions under which marine animals arrive at their fullest development are numerous and peculiar and it is by no means a matter of indifference what portion of the sea-coast we select for our investigations. The various qualities of sea water, its saltness, purity, temperature, rate of current and depth, must all be taken into account; and no less important, in fact often more so, is the nature of the neighbouring shore; whether it is rocky or sandy, barren or fertile and what is its geological formation. Then again, the amount of fresh-water drainage at any particular point, and the greater or less force of the waves have an important influence on the development of the marine fauna. For the classes in which I am more particularly interested: the Radiolites, Medusæ, Siphonophoræ, etc. the most favourable conditions are a deep, land-locked bay of clear still water, undisturbed by the influx of any great volume of fresh water and having strong currents setting towards the shore. Such a combination of favouring circumstances exists, for instance, in the Bay of Messina, the Gulf of Naples and other parts of the Mediterranean shore, long the chosen resort of zoologists. A glance at the map of India will show that such protected bays are of far rarer occurrence along its coast than on the many limbed and deeply indented shores of our glorious Mediterranean. The coast of Ceylon is provided with three only: the two beautiful harbours of Galle and Belligemma on the S. West coast and the magnificent isle-dotted Gulf of Trincomalee on the N. East. This last, Nelson declared to be one of the finest harbours in the world. The English government, quick to see the natural advantages of its dependencies and liberal in turning them to account, lost no time after the acquisition of Ceylon in forming Trincomalee into a fortified and well appointed harbour, by strengthening the forts already erected by the Dutch and by promoting in other ways the prosperity of the town. Much still remains to be done to make Trincomalee worthy of its position as the strongest harbour of refuge along the whole Indian coast. In the struggle in which England is sure sooner or later to be engaged for the possession of her Indian empire, this place will have an important part to play."

To so favourable a spot for the prosecution of his researches, the Professor naturally turned with a longing eye, but the difficulties of the long journey from Colombo to Trincomalee were insurmountable. There is no railway beyond Kandy, and from thence the journey must be made in bullock carts over bad roads and through thick forests. The season too was unfavourable; the heavy rains of the south-west monsoons having swelled the streams and carried away some of the bridges. The carts containing the sixteen chests of instruments, etc., necessary to the Professor's existence, would most assuredly have either stuck fast altogether or only arrived after much delay and with damaged contents. Nor were there any better prospects of a passage by sea. The little steamer usually forming the most direct means of communication for all places on the coast was laid up at Bombay for repairs, and the risk and uncertainty of sailing boats could not be thought of. With much regret, therefore, Professor Haeckel abandoned the idea of Trincomalee, and there only remained for him to decide between Galle and Belligemma. It is a proof at once of his ardour and

[1] Continued from page 275.

sincerity as a man of science that his choice finally fell on the latter. In leaving Galle he turned his back upon civilisation, upon intercourse with fellow-zoologists and upon all the aid which would have been afforded to him by the works of those who had preceded him in similar studies there. But the charm of exploring hitherto untrodden fields of discovery, of pursuing his studies in undisturbed solitude, and, we suspect, of dispensing with the dress-coat, which appears to have been a weight on his mind in all his intercourse with Anglo-Indian society, turned the scale in favour of Belligemma, a little fishing village, inhabited by 4000 Singhalese, without a solitary European among them. Nor had he reason to regret his choice. "The six weeks," he says, "which I spent in Belligemma were overflowing in impressions of beauty which I shall never lose, and are among the most delightful of my Indian memories. I might have found Galle a better and more convenient place for my special zoological purposes, but it could not have been nearly so rich in materials for enriching my views of nature and mankind in general."

Many preparations were necessary for a lengthened stay in so solitary and primitive a place as Belligemma. In the first place, permission had to be obtained from the Governor, Sir James Longden, for the Professor's residence in the Rest-House, since a stay of a few days is all that is usually allowed in these official substitutes for hotels.

The permission was of course, readily granted, and the Professor digresses to give a few words of strong commendation to the order and regularity which everywhere follows British rule, and to the practical good sense with which the Home government varies its mode of dealing with its colonies according to their requirements and idiosyncracies. Ceylon, for instance, is independent of the Indian government, and immediately under the control of the Colonial Minister in London; the Governor is virtually supreme, and seldom has recourse to the decisions of his purely deliberative parliament. It is customary to ascribe to this despotism, so averse to the English nature in general, most of the grievances which affect the prosperity of the island; but better reflection seems to show that a colony containing two and a half million inhabitants, among whom not more than 3,000 are Europeans, requires the concentration of power in a single hand, and that a truer ground for complaint is the Governor's short tenure of office, four years barely sufficing to make him acquainted with the needs of the island and its inhabitants.

Prof. Haeckel's next care was to provide himself with letters of introduction for his stay in Galle, *en route* for Belligemma, and having made all necessary purchases, to see his sixteen chests securely packed on a great two-wheeled bullock cart which was to occupy a week on the road between Colombo and Galle. Bullock carts form the only means of transit for heavy goods in those parts of Ceylon which are provided with roads. The large ones carry as much as forty hundredweight, and are drawn by four humped oxen or zebus. The waggon is a babarous two-wheeled contrivance, with a covering of plaited cocoa-nut leaves, and the weight has to be carefully disposed so as to throw the centre of gravity exactly over the axis of the wheels. Hundreds of such carts, some with two, others with four oxen are thus employed along the roads connecting the towns of Ceylon.

On December 9th, Prof. Haeckel left the hospitable Whist Bungalow, accompanied by the hearty good wishes and judicious counsels of his host and other friends. His description of the journey from Colombo to Galle is graphic and interesting; we must confine ourselves, however, to one or two points, which seem most likely to interest English readers, who may perhaps be already familiar with the main points of a journey so often described. A railway now takes the place of the old carriage road for about one third of the whole distance. The line keeps close to the coast, traversing the palm woods in a direction almost due south and ending at Caltura. The continuation of the line from Caltura to Galle, which would be of the greatest advantage to the latter place, has not been sanctioned by the government from the apprehension that Galle would thereby be enabled to compete with Colombo as the chief town of the island. The intercourse between the two towns is very lively and constantly increasing, so that of the commercial success of the railway no doubt could be entertained. Unhappily, the persistent desire to elevate Colombo to the prejudice of Galle has influenced the Government to refuse a concession to the company that was able and willing to find the capital for the undertaking.

"This action and its motive is the subject of much and very general complaint. Travellers have no resource but either to hire a very expensive private carriage, or to trust themselves to the 'Royal Mail Coach' which makes the journey daily between Caltura and Galle; but this is also very dear and far from comfortable. . . . . The most trying part of this coach journey and of all similar journeys in Ceylon is the cruel torture to which the unhappy horses are subjected. The Singhalese appear to have no idea that driving is an art which does not come by nature; nor that any process of education or 'adaptation' is necessary to prepare horses for going in harness. On the contrary, they appear to think that the whole affair is one of intuition, and that the knowledge of how to pull is hereditary in horses. Without any previous training the unhappy animal is fastened to the carriage by a very clumsy and imperfect harness, and then tortured with every variety of ingenious device, until, in sheer desperation, he sets off at a galop. . . . . The Holy Inquisition itself was not more fertile in resources for bringing heretics to repentance; and as I sat on the box-seat for a quarter of an hour or longer at a time, I often wondered for what sins these unhappy animals could thus, with any justice, be punished. It is possible that similar conjectures arose in the minds of the black coachman and conductor, who no doubt professed Siva worship, and believed in the transmigration of souls. Perhaps they thought that by inflicting these tortures they were avenging themselves on those cruel princes and warriors who once oppressed their people. Either some such idea as this, or their total want of sympathy with the sufferings of animals (perhaps, too, that curious belief existing in some parts of Europe that animals have no feeling), must account for the fact that the Singhalese regard the torturing of horses and oxen as a kind of amusing pastime. The arrival of the mail coach, and the changing of the horses is the great event of the day at every village, and all the inhabitants turn out to watch the proceeding with eager curiosity, to inspect and criticise the passengers, and to take an active part in the torturing of the freshly harnessed horses. When despair at last induces the animals to take flight, they rush in headlong galop, followed by the yells of the assembled crowd, until their breath fails and they fall into a slower pace for about half an hour, when, covered with sweat, with foaming mouths and trembling limbs, they halt at the next station, and are released for a time from their sufferings. It need hardly be said that this mode of travelling is neither pleasant nor devoid of risk to the traveller who trusts himself to the mercies of the Mail Coach driver. The coach itself is often upset and broken to pieces; the terrified horses spring suddenly to one side, or push the coach backwards into a banana bush or a ditch. I was always careful to be ready for a spring from my perch on the box seat. It is scarcely credible that the English government, usually so solicitous for order and discipline should have allowed this cruel treatment of horses to continue so long, and not have taken steps for its repression, at all events as

far as concerned the horses of their own 'Royal Mail Coach.'

"The general character of the landscape varies very little during the whole long stretch of seventy miles between Colombo and Galle, but for all that the eye never tires. The constant charm of the cocoa woods, and the endless variety of the groups of palms prevent any sense of monotony. The glow of the tropical sun is tempered by a cool sea breeze, and by the shade of the palms. It is true, that their feathery foliage does not afford so thick and refreshing a shade as that of our northern forest trees; but very often the slender stems of the palms are covered with a lovely tangle of climbing pepper-wort, and other creepers, which hang in graceful festoons of thick foliage from crown to crown, many of them with blossoms of brilliant hue, such as the flaming *gloriosa superba*, the rose-red Bougainvillea and gay-coloured papillonaceous plants of different kinds. Here and there among the palms stand other trees, such as the noble mango, and the bread-fruit tree, with its thick dark green crown of leaves. The pillar-like stem of the graceful papaya tree (*Carica papaya*), is beautifully inlaid and adorned with a regular diadem of broad, hand-shaped leaves. Different kinds of jasmine, of orange and lemon trees are thickly covered with fragrant white blossoms. And nestling among the trees are the neat white or brown huts with their picturesque surroundings; one would seem to be driving through one long continuous village of palm gardens if one did not occasionally come upon a denser region of forest or upon a real village with its closer row of houses and country bazaar or market place. The road turns frequently towards the sea, and sometimes actually skirts the rocky coast. Here tracts of soft level sand alternate with rocky hillocks picturesquely clothed with the curious pandanus or screw pine. The cylindrical stem of this tree, seldom more than from twenty to forty feet in height, is bent and twisted, and its branches are forked or extended at right angles like a chandelier. Every branch bears at its extremity a thick bunch of large sword-shaped leaves (like the Daacaenæ and the Yucca). Some of the leaves are sea-green, others of a darker shade, all gracefully curved and with a spiral twist at their base, which gives the branch very much the appearance of a screw. At the base of the whole bunch of leaves hang white clusters of blossom with a marvellous perfume, or large red fruit very like the Anana. But the tree is chiefly remarkable for its numerous delicate air-roots, which are given off from the stem and ramify downwards in many directions; when they reach the groundthey take root and serve to support the weak stem. It looks as if the tree were walking on stilts, as it rises above the lower brushwood, pushing its way between the cleft rocks of the shore, or creeping along the ground at their base. The white sand composing the level tracts of the shore is diversified with dark, rocky headlands and animated by brisk little sand crabs so nimble in flight as to have earned the classic name of Ocypode. Numerous hermit crabs too, (Pagurus) wander with a more leisurely pace among their swift-footed cousins, and bear with much dignity the snail shells which protect their soft and sensitive hind-quarters. Here and there sand-pipers, herons, plovers, and other shore birds, are busily employed in catching fish, in formidable competition with the Singhalese fishermen. The latter pursue their calling, some singly, others in companies, in which case they go out in several canoes with enormous nets which they all draw to shore together. (The members of the fisher caste are all Christians, having renounced their Buddhist faith in order to be able to take the life of the fish without deadly sin.) The single fishermen catch their prey by preference in the foaming surf. It is amusing to see the naked brown figures, with only a broad-brimmed straw hat to protect them from sunstroke, spring boldly into the waves and catch the fish in a little hand net. They appear as much in their element in the cool sea water, as do their little children who sport in troops along the shore and swim to perfection at six or eight years old." Among the beauties of this most beautiful journey, Prof. Haeckel further enumerates the river Deltas, of which there are many on this part of the coast, their dark forest of mangrove trees giving the landscape a deeper tone; and also the extensive lagoons which (especially between Colombo and Caltura) connect the rivers of the coast with each other. The Dutch took so much delight in these watery roads as reminiscences of their fatherland, that they formed them into a regular canal system to the neglect of the land roads. Numerous little trading boats sailed along the lagoons from place to place and formed their principal means of communication. But since the English have constructed their present excellent roads, the water traffic has almost ceased.

"The lagoons, with the thick bamboo and palm woods of their shores, with the lovely little islands, and rocky groups mirrored in their bosom, afford to the traveller a succession of enchanting pictures, especially where groups of slender cocoa palms tower over the dark green woodland masses, forming as Humboldt says: 'a forest above the forest.' The long range of hills in the blue distance forms a suitable background, higher mountain summits beyond rising here and there, and the stately dome of Adam's Peak towering over all."

NOTES

JUST three weeks after the sad death of Prof. Balfour, science has sustained another great loss in the death of Mr. W. Stanley Jevons. He was drowned in the sea between St. Leonard's and Bexhill, on Sunday morning, while bathing. He and his wife and family had been staying at Cliff-house, Galley-hill, for the last five weeks. Mr. Jevons was only in his forty-seventh year. Further details we must reserve for next week.

THE death is announced of Prof. Leith Adams, M.A., of the Queen's College, Cork. Entering the Army in 1848 as assistant surgeon, he became Surgeon-Major in 1861. His report on the Maltese cholera epidemic of 1865, and his devotion to the sick, received warm praise. He ultimately retired from the army in 1873 with the rank of Deputy Surgeon-General, and was appointed Professor of Zoology in the College of Science in Dublin, holding the chair till 1878, when he became Professor of Natural History in the Queen's College Cork. He was made a Fellow of the Geological Society in 1870, of the Royal in 1872, an LL.D. of Aberdeen in 1881, and a D.C.S. of the Queen's University a few weeks before his death. His chief works are the "Wanderings of a Naturalist in India," the "Western Himalayas and Cashmere" (1867), "Notes of a Naturalist in the Nile Valley and Malta" (1870), "Field and Forest Rambles, with Notes and Observations on the Natural History of Eastern Canada" (1873), and his "Monograph on the British Fossil Elephants" (1877).

A SCHEME for obtaining in a more effectual manner than hitherto a complete Annual Record of published scientific work is to be brought before the British Association this year by Prof. Sollas, of University College, Bristol. It requires (1) that each nation furnish a record of its own work, and of that only; (2) that each nation receive the records of every other nation in exchange for its own. Each nation would then merely have to classify and translate the records. For the working out of the scheme (*a*) National Committees, and (*b*) an International Congress would be required. The Committees, each consisting of a number of sections, would have, as functions, to produce the national records, to receive and transmit exchanges, to arrange for translations, and to superintend the combination of the sepa-

rate records into a whole. The International Congress should consist of representatives of each of the Committees; and it would aim at securing so much uniformity as would be necessary for the successful working out of the scheme without interfering with the liberty of the Committees; it would also afford an opportunity for the interchange of ideas. Such a Congress might indeed be made a part of an International Association for the Advancement of Science. The scheme presents certain difficulties, especially that of expense, but these will doubtless be fully discussed by the Association when the subject is brought forward.

PROF. PRESTWICH has prepared "An Index Guide to the Geological Collections in the University Museum, Oxford" (Oxford: Clarendon Press), which is of a more general nature than the late Prof. Phillips's "Notices," and includes the large local collections, with regard to which he not only shows the various genera existing at each period, but gives the names of places where the fossils are to be met with. In the series of organic remains the student is enabled to follow the succession of life forms from the earliest palæozoic periods to the present; and in general, the relative place of the specimens in systematic classification and geological age is indicated.

A TELEGRAM from the Swedish Circumpolar Expedition party dated August 6, was received in Stockholm on the 11th inst. *viâ* Tromsö, where it had been brought by a Norwegian fishing smack; the Expedition has been unable to land on account of ice in Mossel Bay, and has in consequence returned to Cape Thordsten on the Norse islands, where the party landed, erected magazines and an observatory, and where observations are now being made. The message states "all well."

IT is noteworthy that Bossekop, one of the Polar stations selected this year for establishing an observatory, has before been occupied by a French scientific mission, sent in 1838 in *La Recherche*. The mission was composed of MM. Lottin, Bravais, and Charles Martin. They sailed in 1838 for Bossekop, where they stayed from September 1 of that year till April 30, 1839. This Polar exploration was followed by observations taken on Mont Blanc. The French North Polar Expedition was sent by the Government in connection with another directed to the Southern Polar seas, and conducted by Dumont d'Urville, who left Toulon on September 7, 1837, with the *Astrolabe* and the *Zeta*. This time English and American expeditions are sent to these remote and dangerous regions.

INTELLIGENCE received at Buenos Ayres, on July 15, announces the wreck at Cape Horn, of the vessel with Lieut. Bove and the members of the Italian Antarctic expedition on board. Lieut. Bove and his companions were saved by the English cutter *Allen Goden*.

ON Monday the annual Congress of the German Anthropological Society began at Frankfort. After an opening address by the President, Prof. Lucae, on the development of anthropology during the last ten years, Dr. Schliemann delivered a lecture on his latest excavations at Troy. He was followed by Prof. Virchow, on Mr. Darwin's relations to anthropology. About 500 members were present.

DR. MACKINTOSH, Superintendent of Murthly Asylum, Perthshire, has been presented by the patron, the Marquess of Ailsa, to the Natural History Chair in the University of St. Andrew's, vacant by the transfer of Prof. Nicholson to Aberdeen.

THE Trustees of the Gilchrist Educational Trust have arranged for courses of "Science Lectures for the People" during the ensuing winter in five towns of Central Lancashire, in five Scotch towns, and in Leicester, Lincoln, Chesterfield, Doncaster, York, Reading, and Banbury. The lecturers who will take part in them are Dr. Carpenter, F.R.S. (the Secretary to the Trust), Prof. Balfour Stewart, F.R.S., Prof. W. C. Williamson, F.R.S., Dr. Martin Duncan, F.R.S., Rev. W. H. Dallinger, F.R.S., and others.

WE learn from the *Photographic Times* (U.S.) that the third Annual Convention and Exhibition of the Photographers' Association of America was to meet at Indianapolis on the 8th inst. Mr. Muybridge, who has returned to America, purposes giving a series of lectures this autumn on instantaneous photography and what it has revealed.

CONCERNING the August meteors, Mr. Donald Cameron writes us from Aberfeldy, under date August 7, that there was a bright display the previous night witnessed by him from the right bank of the Tay. The meteors were many and brilliant, some of them comparing favourably with stars of the first magnitude; but they were very transient and left no traces of light. One of the longest in duration was one shot down at right angles to the horizon from a point equidistant from Saturn and the fifth bright star in Auriga. The region north of the Milky Way (which was bright and well defined) was the principal theatre of the display. At midnight the meteors became very rare, and Mr. Cameron waited till 1 a.m., seeing scarcely any. He remarks on the striking apparent proximity of the stars to the earth in those clear mountainous regions, the brightness of the moon, though, in her last quarter, on the night in question, and the silence of the owls which had been very noisy for some weeks before.

MR. STANFORD has published a Map of the Seat of War in Lower Egypt, on the scale of two miles to the inch; it is exceedingly clear, and likely to be of service to those desirous of watching the progress of operations

THE several designs presented to the Commission for the large dome of the Paris Observatory are being exhibited in the Museum of Astronomy established by Admiral Mouchez. The Commissioners have given the first prize to the design sent in by MM. Cail, of Paris.

M. DUVAUX, the new French Minister of Public Instruction, was formerly director of Nancy College. Since M. Jules Simon resigned, it is the first time that this high office has been given to a professor. This circumstance is considered as being important at a time when public bodies are showing such an interest in the cause of general and special education.

THE brickwork of the subterranean chambers of the Observatory of Paris, constructed for magnetic observations, is now quite finished. Admiral Mouchez intends to use a part of it, in order to study the changes of a mercurial reflecting surface, produced by the attraction of celestial bodies. The changes will be observed with a collimator watching the motion of the reflected image. The determinations will take place in an underground corridor, of which the length is upwards of forty yards and may be considered as being of invariable temperature.

A FIRE, caused by an electrical wire at the Paris Opera House, has created quite a sensation in the scientific world, although it has been successfully kept from the knowledge of the public. Mr. Geoffroy, a wire manufacturer in Paris, has taken a patent for covering electric wires with asbestos. Experiments, which will be repeated officially have proved that the copper can be burned without any spark being conducted outside. Another fatal accident from a similar cause occurred last week in Paris. Two young people wishing to introduce themselves into the Tuileries Gardens without paying th

entrance-fee to a fair, came in contact with the wire conducting the electricity of a Brush machine to the lamps, and were killed instantly.

PROF. MAGGI has recently made a protistological analysis of the water of Lake Maggiore, taken at a depth of about 200 feet between Angera and Arona. There is a proposal, it is known, to supply Milan with potable water from this source. No injurious *bacteria* or *flagellata* were detected. The small deposit, probably from the bottom of the lake, is pronounced innocuous; it consists partly of harmless inorganic matter in reduction, and incapable of further evolution. The few diatom scales in it are harmless, being pure silica. The very small number of live organisms, as an *Amœba radiosa*, Auerb., some Diatoms, and *Chlorococcum vulgare*, Grév., indicate that the water is pure; for otherwise their life would be impossible. The Diatoms and Chlorococcum, feeding on inorganic matter, cannot serve as criteria of the presence of putrescible substances. These organisms were always found alive, even several months after extraction, so that their presence in small quantity could not be very hurtful; still it would be well to purify the water containing them. In fine, Prof. Maggi pronounces the water in question serviceable for industrial and domestic use. (For further details of this research we must refer to the *Rendiconti* of the Reale Istituto Lombardo, vol. xv. fasc. ix., x.).

IN an article on Foreign Chinese Literature the *North China Herald*, in a recent issue, refers to the translation of modern scientific works into Chinese. In May, 1877, a Committee of the general body of missionaries in China was appointed to superintend the publication of a series of scientific and educational works in the Chinese language for use among the Chinese. This project has been carried out ever since, and a large number of text-books are now undergoing translation at the hands of Sinologues. The majority of the workers are missionaries, but their ranks have been largely recruited from other sources. The subjects undertaken are of a most comprehensive nature. They include treatises on logic, mental and moral philosophy, political economy, philology, jurisprudence, the philology and structure of plants, anatomy, mathematical physics, church history, meteorology, astronomy, chemistry, trigonometry, algebra, natural philosophy, zoology, ethnology, mineralogy, physical and political geography, history, besides other works. The undertaking of this large and important series of works reflects the highest credit on the industry and intelligence of the missionary body. But the work of putting the Chinese in possession of the results of Western knowledge has not been confined to the missionaries. The Inspector-General of Chinese Customs, Sir Robert Hart, who is known as an indefatigable educator of the Chinese, is now superintending the translation of a series of scientific text-books into the Chinese vernacular. The Imperial College at Peking is assisting in the work.

A MEETING of Japanese *literati*, versed in European, Chinese, and Japanese languages, was recently held in Tokio. Among those present were the officers of the education and other departments, who regret the confusion and intricacies of the Japanese spoken and written languages. The object of the meeting was to consider the best steps to be taken for purifying the Japanese language from all foreign elements. After a lengthy discussion it was decided to publish grammars and other books in *Kana*, or the syllabary system, without the employment of Chinese characters. A periodical is also to be devoted to the furtherance of this scheme. The project seems a visionary one. The Chinese element in the Japanese language is a very ancient and powerful one. All Japanese philosophy, much of its religion, its arts and sciences, have come from China, and have brought their terminology with them. Even at the present day, when the Japanese want a name for western inventions, for steam, railways, &c., they go to China for them. Not many years since, a Japanese gentleman, who has since risen to a high position in the service of his country, gravely proposed the abolition of all kinds of Japanese and Chinese writing, and the application of Latin letters to the Japanese language. This reform is more radical than that now proposed, but it would seem almost as easy of accomplishment.

WE have received from New South Wales an interesting Report of the Trustees of the Australian Museum for 1881. This Museum is open on Sundays, when the attendance is very large indeed. The total number of visitors was 115,655, being an increase of 3192 on the number for 1880. The number who attended on Sundays was 41,660, being an increase of 8963 on the number for 1880, while the attendance on week-days decreased by 5771. The average daily attendance on week-days was 281, and on Sundays 801. The collections made during the dredging excursion to Port Stephens in November, 1880, were in some orders and families very extensive, but they have not yet been entirely worked out. The crustacea have been determined by Mr. Haswell, and the mollusca by Mr. Brazier. The vertebrates are all well known species, excepting some small deep-sea fishes. Most of the specimens were obtained within Port Stephens itself; and, with some differences in detail, they represent a fauna very similar to that of Port Jackson. The total number of species (invertebrata) procured may be roughly estimated at 700. Of these the mollusca, chiefly of minute kinds, comprise 450 species (1500 specimens), forty-seven of which are new to science. There were obtained also many fine specimens of sponges, of species hitherto unrepresented in the Museum. Among the corals there are several rare species, and some are new. Many other important additions have been made to the Museum. Among the collections purchased have been many very valuable ethnological specimens from the South Sea Islands, of a kind which it is daily becoming more difficult to obtain. A collection of fishes from New Guinea was also purchased. The Trustees are about to publish a Catalogue of the Crustacea of the Australian Seas. This work has been prepared by Mr. W. A. Haswell, M.A., B.Sc., and will be of great scientific value, containing, as it does, descriptions of all known Australian species, many of which are new to science. A Catalogue of the collection of fossils has also been prepared. Both of these will shortly leave the printer's hands. Mr. Brazier has been engaged in cataloguing the collections of shells. The most important work undertaken by the Trustees during the year has been the renewal of the exploration of the caves of the Colony; for which object a special sum of money was voted by Parliament. The bones obtained there are all of recent origin, belonging to still existing species of the kangaroo, wallaby, wombat, opossum, &c. The Siluro-Devonian fossils, however, obtained from the limestone rocks are of considerable interest, and will form a valuable addition to the Museum collection. In one of the caves at Wellington, known as the Breccia Cave, above 1000 specimens were obtained, many of them of great interest; among others an almost perfect ramus of a Thylacoleo with the articulating condyle; and the toe bones of a large species of Echidna. In another cave the tooth of a Diprotodon and some bones of small marsupials were found. In some other shafts the bones were larger and more perfect than those in the Breccia Cave. Among the most important discoveries were portions of the pelvis of an immense kangaroo, caudal and cervical vertebræ; jaws of large marsupials, especially five rami of Thylacoleo nearly perfect, and many good teeth. A list of the most important specimens discovered is contained in the Appendix.

WITH regard to the doctoring of wines by the process known as *plâtrage* (*i.e.* adding plaster of Paris, or calcium sulphate, which decomposes the potassium tartrates, producing sulphate of potassium, and preventing much of the astringent and colour-

ing matter from passing into solution), the Canton of Berne in September, 1879, issued an ordinance, fixing as an upper limit for potassium sulphate in wines so doctored, 2 grammes per litre. Various complaints then arose from merchants, who thought the regulation too stringent; and the Direction of Internal Affairs nominated a Commission, consisting of Herren Lichtheim, Luchsinger, and Nencki to study the subject afresh. In their report (*Journal für Prakt. Chem.*) they come to the conclusions (1) that the perniciousness of plastered wines even when they contain more than 2 gr. sulphate of potassium per litre, is far from being demonstrated indisputably. On the other hand it remains proved that wines strongly plastered have sometimes caused slight accidents, and it results from our theoretic study that the prolonged use of such a drink cannot be without prejudice to health; (2) that we therefore do not think it well to leave the trade in plastered wines without any control. While recognising the difficulty of fixing an absolute limit for plastering, they approve as sufficient that of the ordinance in question; on the one hand, it guarantees the public against illness from use of wines too much plastered, and on the other it is not a heavier fetter for the producer than similar prescriptions in France, where the interest in tolerance of plastered wines is vastly greater. Each buyer who has ordered a natural wine should have the right to refuse any wine containing more than 0·6 gr. neutral sulphate of potassium per litre. The reporters are unable to answer a question as to the action of plastered white wines on the system as compared with red.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. F. Logie Pirie; two Silver Pheasants (*Euplocamus nycthemerus*) from China, presented by Mrs. Hames; a Peregrine Falcon (*Falco peregrinus*), European, presented by Col. A. Brooksbank; a Peregrine Falcon (*Falco peregrinus*) captured at sea off Ceylon, presented by Mr. Tom Broune; six Common Kingfishers (*Alcedo ispida*), British, presented by Mr. T. A. A. Burnaby; two Slow-worms (*Anguis fragilis*), two Common Vipers (*Vipera berus*), British, presented by Mr. Charles Taylor; a Moustache Monkey (*Cercopithecus cephus*) from West Africa, two Common Ravens (*Corvus corax*), British, two Common Boas (*Boa constrictor*) from South America, deposited; two Shags or Green Cormorants (*Phalacrocorax cristatus*), European, purchased.

CLIMATE IN TOWN AND COUNTRY [1]

THE speaker began by describing the construction and uses of the instruments with which he had studied the conditions of climate, for many years past, in various parts of Europe. For the determination of sun temperature, he used a thermometer technically known as the blackened bulb *in vacuo* laid in full sunshine upon a sheet of white paper. The shade or air temperature was measured by an ordinary thermometer with a clear glass bulb and a scale engraved upon the stem. This thermometer was placed upon the same sheet of paper, and was shaded by a small white paper arch which admitted of a free circulation of air around the bulb.

He then explained the terms "sun temperature," "shade temperature," and "solar intensity." By shade temperature is meant the temperature of free air in full sunshine. Strictly it ought to be ascertained without any shade at all; for as soon as a shade is produced, conditions are introduced which often entirely baffle the object of the observer. The shade of a parasol has a different temperature from the shade of a tree, and this, again, differs widely from that of a house. The temperature of the shade of a sheet of tinfoil is quite different from that of a sheet of writing paper. Indeed it may be truly said that every shade has its own peculiar temperature. The following table shows the effect of the area of shade, and of the quality of the shading material:—

Beneath larch tree	19°·5 C.
,, white parasol	25·0
,, small white paper arch	35·0
,, small arch of bright tinfoil ...	45·2

Thus shade temperatures, measured during $1\frac{3}{4}$ hours of uninterrupted sunshine in the middle of the day, and within a few yards of the same spot, differed by no less than 25°·7 C. These observations were, however, made at Pontresina, 5,915 feet above the sea-level, and so wide a range does not occur at lower altitudes.

The most effective shading material is, obviously, that which most perfectly reflects solar heat; and of all materials with which he had experimented white paper was found to be the best, white linen and zinc-white being nearly equal to it. The most trustworthy shade thermometer, therefore, is one having its bulb covered with a thin layer of one of these materials; or the naked layer may be shaded by a small arch of white paper.

The term "sun temperature," as commonly employed, has a very vague meaning. If a body could be placed in sunlight under such circumstances as to absorb heat rays and emit none, its temperature would soon rise to that of the sun itself. But, as all good absorbers of heat are also good radiators, the elevation of temperature caused by the exposure of even good absorbers to sunlight is comparatively small. Thus an isolated thermometer, with blackened glass bulb, placed in sunshine, will rarely rise more than 10° C. above the temperature which it marks when screened from direct sunlight. Under these circumstances, however, the thermometer loses heat not merely by radiation, but also by actual contact with the surrounding cold air. If the latter source of loss be obviated, a much higher sun temperature is obtained. Thus, the blackened bulb enclosed in a vacuous clear glass globe will sometimes, when placed in sunlight, rise as much as 60° C. above the shade temperature, and a still higher degree of heat may be obtained by exposing to the sun's rays the naked blackened bulb of a thermometer enclosed in a wooden box padded with black cloth, and closed by a lid of clear plate glass. Thus he obtained with such a box, on the 22nd of December, in Switzerland, when the air was considerably below the freezing point, a temperature of 105° C., and a still higher temperature could doubtless be obtained by surrounding the thermometer with a vacuous globe before enclosing it in the padded box. These widely different temperatures, produced under different conditions by the solar rays, show that such observations can be comparative only when the thermometer employed to measure them is always surrounded by the same conditions. All the sun temperatures here mentioned were measured when the "blackened bulb *in vacuo*" was laid horizontally upon a sheet of white paper with its stem at right angles to the direction of the sun's rays.

"Solar intensity" is relative only, and means the number of degrees through which the sun raises the temperature of a blackened bulb *in vacuo* over the shade temperature. Hence the two temperatures must be observed simultaneously, which is a laborious operation when continued half-hourly throughout the day. By the use of a peculiar self-registering differential thermometer, however, which he had recently described to the Royal Society (*Proceedings* of the Royal Society, 1882, p. 331), the maximum solar intensity during the day is recorded by one reading only. The solar intensities commented upon in this discourse were ascertained by subtracting, in each case, the shade temperature from the sun temperature taken synchronously. The precautions necessary are described in the paper to the Royal Society just quoted.

The chief things affecting climate are the following:—(1) The sun. (2) Land and water—ocean and atmospheric currents. (3) Aspect—slope of ground, exposure or shelter. (4) Nature of surface. (5) Reflection from land and water. (6) Rain and clouds—suspended matter in the air. (7) Latitude—incidence of solar rays, thickness of air. (8) Presence or absence of aqueous vapour. Of these, the first three are obvious and require no comment. The remainder are less well known, but their importance demands our special attention.

Climate, or rather genial climate, is ultimately resolvable into two prime factors—sun-warmth and air-warmth. The amount of sun-warmth (assuming the sun's heat to be constant) depends upon two things only—length of day, and quantity of suspended matter and aqueous vapour in the air. The warmth of the air depends upon contact with matter heated by the sun's rays and upon the stoppage of radiation from the earth by aqueous vapour.

[1] Lecture delivered at the Royal Institution of Great Britain, February 10, 1882, by E. Frankland, Esq., D.C.L., F.R.S., M.R.I., Professor of Chemistry in the Normal School of Science, South Kensington Museum.

This heated matter is:—(1) Sea or land. (2) Suspended matter in the air—cloud, dust, smoke. (3) Aqueous vapour.

These two factors were first considered in their relation to

Country Climate

The feeling of warmth and comfort in the open air is produced either by direct solar radiation, even if the air be very cold; or by the warmth of the air itself. Upon both of these, the nature of the surface upon which the sunlight falls has a paramount influence, as is seen from the results of experiments on sun temperature recorded in the following table:—

Influence of Surface

Norway.	
Green grass	57·3° C.
Parched grass	61·2
Bare soil	60·6
Newly-mown grass	56·5
White paper	73·5
Hesse Cassel.	
Black caoutchouc	54·7° C.
Black silk	56·5
Plane glass mirror	64·0
Slightly concave metallic mirror	64·0
Green grass	58·5
White paper	67·7
Switzerland. Mortaratsch Glacier.	
Black caoutchouc	39·0° C.
Bare white ice	47·5
White paper	53·0
Summit of Gornergrat.	
Dazzling white snow	59·0° C.
White paper	61·2
Pontresina.	
White paper	66·2° C.
Grass	54·0
Grey rock	54·0
Black caoutchouc	56·4
Diavolezza.	
Black caoutchouc	39·1° C.
Snow	61·9
White paper	65·8
Italy. Bellagio.	
Black caoutchouc	60·0° C.
Black merino	59·0
White linen	66·0
White paper	66.3

These results may be imitated with the powerful light from a Siemens' dynamo-machine. [Experiments shown.]

The warmth of the air over these surfaces was in the inverse order, caoutchouc heating the air most, white paper and snow least. The nearer the colour of the ground approaches to *white*, the more genial will be the climate from radiation and the cooler will be the air. The nearer it gets to *black*, the warmer will be the air and the less will temperature be due to radiation. Dark surfaces warm the air; light surfaces keep it cool, but warm the body by radiant reflection. The difference is substantially the same out of doors as that produced indoors by a close stove on the one hand, and an open fire on the other; but calm air is required for the enjoyment of radiant heat.

The sun's radiant heat may be greatly reinforced by reflection from surrounding objects. There are two kinds of reflectors; those which, like white paper, white linen, and whitewash, scatter the solar heat in all directions, and those which, mirror-like, reflect it in one direction only. To the former belong snow, chalk, light-coloured sand, and light-coloured earth; to the latter, water. The former are useful on whatever side they may be, the latter only when they are between the observer and the sun. The observations in the following table illustrate this effect of reflection from surrounding objects:—

Influence of Reflection from Surrounding Objects

From a white-washed wall. Pontresina.	
On white paper 10 feet from wall	38·7° C.
in adjoining meadow	27·7
From water. Top of cliff at Alum Bay, Isle of Wight.	
Direct and reflected rays	31·2° C.
Direct rays only	25·7
Zürich. One mile from Lake.	
Direct and reflected rays	34·0° C.
Direct rays only	31·5

M. Dufour has observed the same phenomenon on the lake of Geneva between Lausanne and Vevay. He has measured the proportions of direct and reflected heat at five different stations on the northern shore of the lake, and the results are condensed in the following table:—

Dufour's Observations

Altitude of Sun.	Proportion of direct to reflected heat.
3° 34′ to 4° 38′	100 : 68.
7°	100 : 40 to 50.
16°	100 : 20 to 30.

When the sun was higher than 30° the reflected heat was hardly perceptible. Hence this reflection is of the greatest value in winter, when it is most wanted, and it also tends to equalise temperature during the day; for in the early morning and evening, when the sun is low, and his direct heat is small, the reflected heat is greatest.

The bearing of these observations upon winter refuges for invalids is obvious. While the primary conditions to be secured must ever be fine weather and a sheltered position, the next in importance is, doubtless, exposure all day long to reflected, as well as direct, solar radiation. To realise this, a southern aspect and a considerable expanse of water or snow are necessary. and it is important that the sanitarium should be considerably and somewhat abruptly elevated above the reflecting surface, so that it may receive, throughout the entire day, the uninterrupted reflection of the sun's rays. At or near the sea-level, however, it is impossible, owing to solid and liquid matters floating in the lower regions of the atmosphere, to enjoy anything approaching to a uniform temperature from sunrise to sunset.

Although this suspended matter exists even at great altitudes, the bulk of it floats below 5,000 feet, and whilst only one-sixth of the atmosphere is below this height, there is probably much more than one-half of the suspended matter at a lower elevation. As might be expected, therefore, solar intensity is much greater at high than at low elevations, although the temperature of the air continually decreases as it is further removed from the earth's surface. The following tables contain observations illustrative of this point:—

Solar Intensity.

Station	Height of Barometer. Inch.	Sun's Altitude. °	Indicated Solar Intensity. °C.
Oatlands Park	29·9	60	41·5
Riffelberg	22·0	60	45·5
Hörnli	21·2	61	48·1
Gornergrat	20·5	61	47·0
Isle of Wight	30·0	58	42·3
Riffelberg	22·0	60	45·5
Piz Languard	20·2	54	45·8
Whitby	30·1	50	37·8
Pontresina	24·0	49	44·0
Bernina Hospitz	22·6	51	46·4
Diavolezza	20·8	50	59·5
Bellagio	29·3	47	39·8
Shiahorn	21·6	46	43·5
Schwarzhorn	20·3	46	45·5

SHADE TEMPERATURES AT NOON AND DIFFERENT ALTITUDES

Station.	Height above Sea. Inch.	Sun's Altitude. °	Temperature. °C.
Oatlands Park	150	60	30·0
Riffelberg	8,428	60	24·5
Hörnli	9,491	61	20·1
Gornergrat	10,289	61	14·2
Whitby	60	50	32·2
Aak, Romsdal	20	49	36·2
Pontresina	5,915	49	26·5
Bernina Hospitz	7,644	51	19·1
Diavolezza	9,767	50	6·0
Bellagio	700	47	28·5
Shiahorn	8,924	46	23·0
Schwarzhorn	10,338	46	20·5

Hence it follows that the difference of solar intensity between noon and sunrise and sunset respectively is less at great than at small elevations, a deduction which is substantiated by the experimental data contained in the following table :—

VARIATION OF SOLAR INTENSITY AT DIFFERENT HOURS.

Station.	Time.	Solar Intensity. °C.	Difference. °C
Isle of Wight	Noon	42·3	7·6
,, ,,	3·30 P.M.	34·7	
,, ,,	Noon	42·1	8·5
,, ,,	3.15 P.M.	33·6	
,, ,,	Noon	41·7	8·4
,, ,,	3.50 P.M.	33·3	
At Sea	8.30 A.M.	33·8	7·9
,,	Noon	41·7	
Riffelberg (8,428 ft.)	8.20 A.M.	40·9	4·6
,, ,,	Noon	45·5	
Gornergrat (10,289 ft.)	,,	47·0	5·3
,, ,,	3 P.M.	41·7	

Similar testimony is also afforded by a comparison of early and late observations at widely different altitudes :—

VARIATIONS OF SOLAR INTENSITY AT DIFFERENT ALTITUDES

Station	Time. A.M.	Sun's Altitude at Noon.	Height above Sea. Feet.	Solar Intensity. °C.	Difference °C.
At Sea	7.35	72	0	28·6	8·6
Riffelberg	7.45	60	8,428	37·2	
At Sea	8·8	72	0	30·3	10·6
Riffelberg	8.20	60	8,428	49·2	

The sun's altitude was unfavourable for the comparison; nevertheless, there were here observed differences of 8·6° C. and 10·6°.

The farther we recede from the earth, the nearer we realise the conditions of solar radiation altogether outside the limits of the atmosphere, where the solar intensity (assuming the sun's emission to remain constant) is uniform from sunrise to sunset. Throughout the dreary winter days, when, even in the country, a leaden sky oppresses us, it is tantalising to reflect that, at the moderate height of 5,000 feet, which can be reached by a balloon in a few minutes, there is probably blue sky and brilliant sunshine.

Latitude profoundly, though irregularly, affects air temperature, for in high latitudes less solar heat falls upon each square foot of the earth's surface, and therefore the air resting upon that surface is warmed to less extent. But obliquity of the sun's rays has no such influence on solar intensity, for the highest readings of solar heat at or near sea-level have been observed near to the Arctic circle, as is seen from the following table :—

SOLAR INTENSITY IN DIFFERENT LATITUDES.

Station.	Latitude. °	Sun's Altitude. °	Sun Temperature. °C.	Solar Intensity. °C.
At Sea	0	84	78·9	41·7
Oatlands Park	52 N.	61	75·0	45·0
Isle of Wight	51 ,,	58	72·3	42·3
At Sea	23 ,,	56	71·7	45·0
Cassel	51 ,,	53	68·7	—
Tosten Vierod	59 ,,	52	73·5	—
Whitby	54 ,,	50	67·8	36·8
Aak, Romsdal	63 ,,	49	82·5	48·7
At Sea	30 ,,	48	70·3	43·6
Bellagio	45 ,,	47	68·3	39·8

These results show that, with an obliquity of only 6°, the sun temperature and solar intensity were respectively only 78·9° and 48·7° C.; whilst with an obliquity of 41°, there were 82·5° and 48·7° C. *On the equator at noon, with a nearly vertical sun, the solar intensity was actually 7° C. lower than in Romsdal, only 4° S. of the Arctic circle.* On the other hand, air warmth diminishes, as a rule, with increase of latitude, although, as the following table shows, there are some remarkable exceptions, for it was 1° higher in lat. 52° N. with an obliquity of 29°, than in lat. 5° N. with an obliquity of only 12°, and in the high latitude 63°, with an obliquity of 41°, it was only 1° C in arrear of the air-warmth at the equator with an obliquity of only 6°.

SHADE TEMPERATURE AT OR NEAR NOON AND SEA-LEVEL.

Station.	Latitude. °	Sun's Apparent Altitude. °	Temperature. °
At Sea, April 10	45 S.	37	18·9
,, March 23	31 ,,	58	26·3
,, ,, 22	29 ,,	60	29·7
,, ,, 18	27 ,,	65	32·5
,, ,, 17	23 ,,	68	32·8
,, ,, 16	20 ,,	71	29·4
,, ,, 13	11 ,,	82	37·2
,, ,, 12	10 ,,	83	37·2
,, ,, 11	9 ,,	85	36·5
,, ,, 6	0 ,,	84	37·2
,, ,, 4	3 N.	81	30·0
,, ,, 3	5 ,,	78	29·4
,, ,, 2	8 ,,	75	31·7
,, Feb. 24	17 ,,	64	28·0
,, ,, 20	21 ,,	58	28·3
,, ,, 19	23 ,,	56	27·2
,, ,, 16	30 ,,	48	28·9
,, Jan. 27	51 ,,	21	10·6
Bellagio, Sept. 17	45 ,,	47	28·5
Oatlands Park, June 8	52 ,,	61	30·0
Isle of Wight, May 13	51 ,,	57	28·9
,, ,, ,, 14	51 ,,	58	29·0
,, ,, ,, 15	51 ,,	58	30·0
Whitby Aug. 16	54 ,,	50	32·0
Aak, Romsdal, July 15	63 ,,	49	36·2

Shortly summarised, therefore, the conditions most favourable for a genial climate—

Depending on solar intensity are—

1. Great elevation above sea-level.
2. A light coloured ground and back-ground.
3. Shelter. Reception of direct and reflected rays.
4. A clear sun with white clouds.
5. A clean atmosphere. No dust, smoke, or fog.
6. A minimum of watery vapour in the air.

Depending on air temperature, are—

1. Slight elevation above sea-level.
2. A dark coloured ground and back-ground.
3. Shelter. Reception of direct and reflected rays.
4. A clear sun with white clouds.
5. A clean atmosphere. No dust, smoke, or fog.
6. A maximum of watery vapour in the air.

Thus whilst there are three conditions common to both categories, the three remaining ones are diametrically opposed to each other.

TOWN CLIMATE.

The climate of towns depends upon the same essential conditions as that of the country, but some of these are more within our own control in towns.

The great evils of our town climate are excessive heat in summer and cheerless gloom in winter. We suffer less, however, from excessive solar intensity than continental cities between the same parallells of latitude, owing to the very causes which plunge us into a more miserable gloom in winter. Light-coloured walls neither make our streets look cheerful nor feel hot. Such sad colours as brick, stone, stucco, or paint give to our houses are soon changed to a grimy neutral tint, powerless to reflect either solar light or heat.

The darker the colour of the houses, the cooler the streets and the hotter the rooms during sunshine, and *vice versa*. Whilst the summer climate in our streets and houses is thus, to a considerable extent controllable, that of winter, which depends so much on a clean atmosphere, is still more so. All our towns are nearly

at the sea-level, a position favourable for air-, but not for sun-warmth. In our large towns, however, we artificially create an impenetrable barrier to solar radiation by throwing into the air the imperfectly burnt products of bituminous coal.

These products are of three kinds—soot, tar, and steam. Every ton of bituminous coal burnt in our grates gives off about 6 cwts. of volatile but condensable products. The less perfect the combustion the more tar and the less steam will be produced. If perfectly burnt without any smoke, then about 9 cwts. of steam, occupying 27,359 cubic feet at 100° C., or 20,024 cubic feet at 0° C. will be sent into the air. Now, 33,333 tons of bituminous coal are, on the average daily consumed in London in winter, giving 667,460,000 cubic feet of steam at 0° C.

This combustion of enormous quantities of bituminous coal acts in the production of town fog in three ways:—1st. By supplying the basis of all fog—condensed watery particles. 2nd. By determining the condensation of atmospheric moisture in the form of fog. 3rd. By coating the fog particles with tar, and thus making them more persistent.

All fogs have for their basis watery particles, and the greater part even of the suspended matters visible in a ray of electric light consists of these particles, for the air becomes nearly clear when it is heated somewhat above 100° C. [Experiment shown]. Everything therefore which increases the proportion of aqueous vapour in town air tends to produce fog. But aqueous vapour alone would probably never produce fog, for it condenses at once to large particles, which rapidly fall as rain. When, however, solid or liquid particles are present in the air, the minute spherules of fog are produced. This was first shown by Messrs. Coulier and Mascart, in 1875, and their results have since been confirmed by Mr. Aitkin. The speaker showed that air filtered through cotton wool, though afterwards saturated with moisture, produced no fog when its temperature was lowered; but as soon as a small quantity of the dusty air of the theatre was admitted fog was immediately formed, whilst, when a little coal smoke was introduced, a dense and more persistent fog was the result.

The fog once formed is rendered more persistent by the coating of tarry matter which it receives from the products of the imperfect combustion of smoky coal. The speaker had made numerous experiments on the retardation of evaporation by films of coal tar. He had found that the evaporation of water in a platinum dish placed in a strong draught of air was retarded in one experiment by 84 per cent. and in another by 78·6 per cent., when a thin film of coal tar was placed on the surfaces. Even by the mere blowing of coal smoke on the surface of the water for a few seconds, the evaporation was retarded by from 77·3 to 81·5 per cent. Drops of water suspended in loops of platinum wire were also found to have their evaporation retarded by coal smoke. Hence arise the so-called dry fogs which have been observed by Mr. Glaisher in balloon ascents, some examples of which are given in the following table:—

FOG IN COMPARATIVELY DRY AIR.

Place of Ascent.	Altitude.	Temperature of Air.	Degree of Humidity.
	Feet.	°F.	100 = saturation.
Wolverhampton	5,922	53·5	61
Crystal Palace	3,698	38·5	62
" "	9,000	32·5	52
" "	1,000	64·7	53
Wolverton	11,000	30·0	68
Woolwich	6,000	44·0	64
"	4,400	42·0	52

Thus the smoke of our domestic fires constitutes a potent cause both for the generation and the persistency of town fogs. In London, at all events, if all manufacturing operations were absolutely to cease, the fogs would not be perceptibly less dense or irritating. Granting then this cause of town fogs, what are the remedies open to us? The speaker was of opinion that the substitution of a sufficient number of smoke-consuming grates (assuming a smoke-consuming grate to have been invented), for the 1,800,000 fire-places of London was quite hopeless, and that one remedy only could be of any appreciable service—*the importation of bituminous coal must be forbidden*. This is a case in which individual effort can do nothing; but State or municipal action would be simple and decisive.

There need be no fear that the price of smokeless fuel would rise inordinately, for the sources of this fuel are too numerous and inexhaustible to admit of either a monopoly or a serious rise in price. In addition to the enormous stores of smokeless coal in the Welsh coal-fields, every bituminous coal yields a smokeless coke, either in the retorts of gasworks or in coke ovens. On the average, 100 tons of smoky coal yields 60 tons of coke, the remaining 40 tons being driven off as combustible gas, ammoniacal liquor and tar; and as there is an almost unlimited demand for these products, it is not unlikely that they would, under the circumstances contemplated, repay the cost of coking, and it is worthy of note that coal of very inferior quality makes fairly good coke.

The only objection to the domestic use of smokeless coal and coke is the difficulty of lighting the fire, but this is obviated by the use of gas as proposed by Dr. Siemens. In ordinary grates, however, there is little difficulty in lighting and burning these smokeless fuels if the throat of the chimney be contracted so as to increase the draught. In this way nearly every grate in London could be rendered smokeless at an expenditure of a couple of shillings.

It is unnecessary to enumerate the many advantages of a smokeless atmosphere, but it may here be mentioned that London fogs not only seriously injure health but annually destroy the lives of thousands. In one week alone upwards of 1,100 lives have been thus sacrificed in London. We have doubtless still long to wait before the only remedy for London fogs will be adopted; but in the meantime, immunity from their effects, so far as the respiratory organs are concerned, may be obtained by the use of a small and very portable cotton-wool respirator which is made, in accordance with the speaker's directions, by Mr. Casella, of Holborn. [Respirator exhibited.] Armed with this little instrument, he had often passed through the densest and most irritating fogs with perfect immunity, breathing, in fact, all the time, air even purer than that of the country. Such a remedy is, however, obviously of extremely limited application.

In conclusion he said, though we may, with justice, complain of the scanty share of sunshine now received by us, let us not forget that, in our coal-fields, we are compensated by vast stores of the sunlight of past ages. How far through electricity, these stores can be evoked to supplement the present defective supply, he would be a bold man who would venture to predict. Let us not, however, continue to use this great legacy of light of the past to obscure the small one of the present.

SCIENTIFIC SERIALS

American Journal of Science, July.—Contributions to meteorology (seventeenth paper), by E. Loomis.—The phenomena of metalliferous vein-formation now in progress at Sulphur Bank, California, by J. Le Conte and W. B. Rising.—Modes of occurrence of the diamond in Brazil, by O. A. Derby.—On the influence of time on the change in the resistance of the carbon-disc of Edison's tasimeter, by T. C. Mendenhall.—Further observations on the crystallised sands of the Potsdam sandstone of Wisconsin, by A. A. Young.—On the origin of jointed structure, by G. K. Gilbert.—Break-circuit arrangements for transmitting clock-beats, by F. E. Nipher.—Cirriped crustacean from the Devonian, by J. M. Clarke.

Archives des Sciences Physiques et Naturelles, No. 7, June 15.—Contribution of astronomy to the solution of a problem of molecular physics, by M. R. Pictet.—Study of the variations of kinetic energy of the solar system, by MM. Pictet and Cellerier. Swiss Committee of Geological Unification, by M. Renevier.—On a characteristic of the Batatas, whose singularity in the family of the Convolvulaceæ has not been sufficiently remarked, by M. de Candolle.—Observation of Mr. Meehan on the variability of the English oak (*Quercus robur*), and remark by M. de Candolle.—Note on Echinida gathered in the environs of Camerino (Tuscany), by M. Canavari.

No. 7, July 15—On the rotatory polarisation of quartz, by MM. Soret and Sarasin.—On the diffusion of bacteria, by M. Schnetzler.—Petrogenic classification or grouping of rocks according to their mode of formation, adopted for academic instruction and for the museum of Lausanne, by M. Renevier.

SOCIETIES AND ACADEMIES

VIENNA

Imperial Academy of Sciences, July 13.—O. Tumlirz, on a method for researches on the absorption of light by

coloured solutions.—G. Gruss and K. Koegler, on the orbit of *Oenone* (215).—I. Tesar, kinematic determinations of the outline of a warped screw-plane.—A. Wassmuth, on an application of the mechanical theory of heat to the process of magnetisation.—W. Fossek, on some new derivates of isobutylaldehyde.—H. Weidel and R. Brix, contribution to the knowledge of cinchonic and pyrocinchonic acid.—A. Freund, on trimethene.—I. v. Hepperger, computation of the way of the comet 1874 III. (Coggia).

PARIS

Academy of Sciences, August 7.—M. Blanchard in the chair.—The following papers were read:—Researches on the action of ethylenic chlorhydrin on pyridic bases and on chinoline, by M. Wurtz.—Employment of photography to determine the trajectory of bodies in motion, with their velocities at each instant and their relative positions; applications to animal mechanics, by M. Marey. A body brightly illuminated is set in motion before a dark screen, and its path photographed on a very sensitive plate. Thus M. Marey obtained the path of a stone wrapped in white paper and thrown in the air; such a stone whirled by means of a string; the same while a person walked forward; a black baton with terminal white ball, with which the author traced the letters of his name, &c. To indicate velocity, the light is interrupted (say) 100 times a second, by rotation of a spoked wheel; and to determine synchronism of motion of different parts of a moving body, one of the spokes is broadened to double the length of eclipse at intervals.—On the sensibility of the cerebral lobes in mammalia, by M. Vulpian. He is unable to confirm M. Couty's observation of movements provoked by mechanical stimulation of the grey cerebral cortex. He considers the substance of the cerebral lobes to have but little sensibility.—A note from M. Vaison, at Saint Denis (island of Reunion), stated that a comet was there seen on June 16 in the Crab, with nucleus comparable to a star of the second magnitude.—Remarks concerning the problem of Kepler, by M. Radau.—Observations of solar protuberances, faculæ, and spots at the Royal Observatory of the Roman College, during the first six months of 1882, by P. Tacchini. The oscillations of the protuberances, north and south, are regular and periodic; the period of oscillation is less manifest for the spots, and for the faculæ it fails entirely. Spots and faculæ present two maxima, between ± 10° and ± 30°, as in the last half of 1881; (the faculæ reach higher latitudes than the spots). The protuberances figure in all zones, and their maxima correspond to those of the faculæ and spots. The minimum of protuberances, observed in December, extended into January; then there was an increase till March. Another minimum occurred in May.—On the longitudinal vibrations of elastic bars, &c. (continued) by MM. Sebert and Hugoniot.—On the elasticity of rarefied gases, by M. Amagat. Having repeated his experiments with modified apparatus (especially the differential barometer), he affirms that down to the lowest pressures (and he reached two-tenths of a millimetre), there does not seem to occur a sudden change in the law of compressibility of gases. They still follow the law of Mariotte with little divergence.—On the influence of a quantity of gas dissolved in a liquid on its superficial tension, by M. Wroblewski. In contradiction of M. Kundt's theory, he finds that lowering the temperature, instead of retarding the decrease of surface tension, accelerates it. The phenomena are quite independent of pressure, and depend on the state of saturation of the liquid surface (or quantity of gas dissolved in the surface layer).—Numerical relations between thermal data, by M. Tommasi. When one metal is substituted for another in a saline solution, the quantity of calories liberated is, for each metal, always the same, whatever the nature of the acid forming part of the salt or of the halogen body united to the metal.—Researches on the telephone, by M. d'Arsonval. Various facts prove that the really active part of the wire is that lodged between the poles of the magnet; thus in the two-pole telephones, all the wire not between the poles may be considered useless resistance. He describes an instrument realising this idea; it transmits with great force and distinctness.—On the equivalent of iodides of phosphorus, by M. Troost.—Heat of formation of the principal palladium compounds, by M. Joannis.—Factitious purulent ophthalmia produced by the liquorice-liana (*Abrus precatorius*) or the jequirity of Brazil, by M. de Wecker.—Researches on chinoline and on lutidine, by M. Amé Pictet.—The vaso-dilator nerves of the ear, by MM. Dastre and Morat.—Researches on the pancreas of cyclostomes, and on the liver without excretory canal of *Petromyzon marinus*, by M. Legouis.—Direct observation of the motion of water in the vessels of plants, by M. Veigne. He describes microscopical observations on cut stems of *Tradescantia zebrina* and *Hartwegia comosa* verifying recent views of M. Boehm.—Simultaneous existence of flowers and insects on the mountains of Dauphiné, by M. Musset. Flowers and insects being never simultaneously and mutually wanting, Heckel's objection to cross-fertilisation on the score of absence or rarity of these auxiliary animals on flower-bearing summits loses all value.—M. Bigi presented a self-winding clock, depending on thermo-electric currents produced by variations of temperature.

BERLIN

Physiological Society, July 28.—Prof. Du Bois Reymond in the chair.—Dr. Saltet has, by a series of experiments in the Berlin Physiological Institute on frog's hearts that were traversed by different liquids, and placed in various baths, sought to determine the cause of their fatigue. It appeared that the carbonic acid formed by the heart-muscle in its action acts prejudicially to its nutrition and work; it diminishes the height and frequency of the pulse, so long as it is in contact with the muscle-fibres. On the other hand, fatigue of the heart does not occur, when, by strong contraction, the carbonic acid is separated from the muscle-fibres, and, mixing with the nutritive liquid, is carried away with it. For prevention of fatigue, moreover, those baths acted very favourably, into which the carbonic acid easily diffused, *e.g.* alkaline and ordinary salt-solutions; whereas, in an oil-bath which does not take up the carbonic acid, fatigue occurs very quickly, under like conditions. A heart fatigued in the oil bath, being brought into a salt solution, while the same nutritive liquid passed through, the fatigue disappeared, and the pulsations reappeared, probably because the carbonic acid could now diffuse away. Quite similar results were arrived at by Herr Joseph Denys by experiments on other involuntary muscles of the frog, whose contractions, with maximum stimulation, were indicated by the kymographion. It appeared from this investigation, also carried out under the guidance of Prof. Kronecker, that carbonic acid is the most probable cause of the diminished work, as the curves increased in height when, during rest, the muscle was traversed by liquids which could absorb the carbonic acid.—Prof. Kronecker reported finally on experiments by Dr. Wedenski, on the muscle tone in electric stimulation. The observations were made with a telephone, and showed an essential agreement between the number of the vibrations heard and the frequency of the electric stimuli. On voluntary contraction of his arm-muscles, Dr. Wedenski heard a deep humming tone, whereby, on the whole, the data of previous observers as to the pitch of the muscle-tone were confirmed.

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